REPORTS OF THE TECHNICAL WORKING GROUPS

ESTABLISHED UNDER THE THEMATIC STRATEGY FOR SOIL PROTECTION

VOLUME - I

INTRODUCTION AND EXECUTIVE SUMMARY

Editors

Lieve Van-Camp, Benilde Bujarrabal
Anna Rita Gentile, Robert J A Jones
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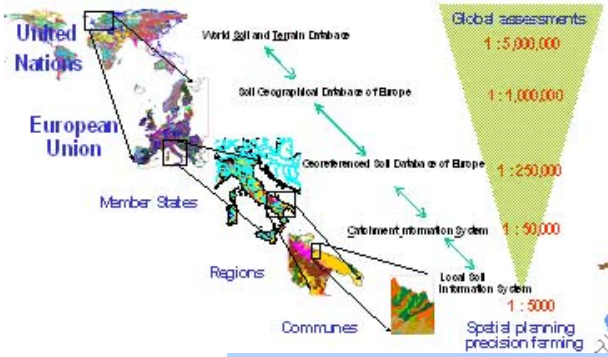
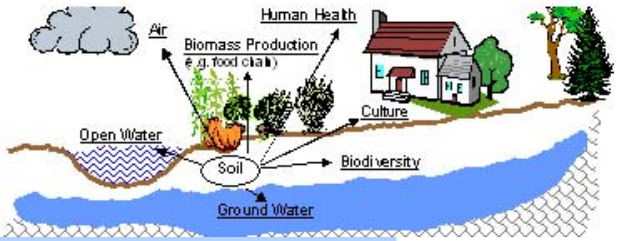
Senthil-Kumar Selvaradjou





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Introduction

Brief History on the Thematic Strategy for Soil Protection and Sustainable Use

The concept “Thematic Strategies” appears in the Commission’s proposal on the sixth Environmental Action Programme (6EAP) which the Commission adopted on 24 January 2001. The final text on the 6EAP, adopted by the European Council and the European Parliament on 22 July 2002 dedicates a specific article on Thematic Strategies and lists a total of 7 strategies to be delivered for the following areas: soil, marine, air, pesticides, urban, waste and resources. In the meantime several other areas of environmental policy are following the staged and participatory approach of the thematic strategies.

The “Towards” Communication on soil protection

Soil is a vital and non-renewable resource and had not been the subject of comprehensive EU action. Soil is nevertheless an old area of research which developed over at least the last 50 years. During the second half of the previous century several Member States developed soil policies at different degrees of intensity. However at EU level first signs in the direction of a coherent soil policy have been given recently, with the adoption of the 6EAP and the adoption of the first Communication on soil protection in April 2002 (the “Towards” Communication), which has placed the spotlights on this “forgotten” environmental medium.

Commenting on the launch of the first communication on the thematic strategy for soil protection in April 2002, Environment Commissioner Margot WALLSTRÖM said: "*We are now placing soil protection on a level with cleaning up our water and air. For too long, we have taken soil for granted. However, soil erosion, the decline in soil quality and the sealing of soil are major problems across the EU. This is a sustainability issue given that these trends are largely irreversible and that soil is vital for our livelihood.*".

The publication of this first soil Communication was the first occasion on which the Commission addressed soil protection for its own sake. Since then the European Insitutions have expressed their opinions on this Communication and on the way forward for the develoment of a strategy for European Soils. Both the original text of the Commission’s Communication and the opinions of the European Institutions (European Council, European Parliament, European Committee of the Regions, European Economic and Social Committee) are available in all language versions at: *http://europa.eu.int/comm/environment/soil/index.htm*

Key features of thematic strategies

Thematic strategies are conceived as priority actions within key environmental areas: they are envisaged as a way to tackle key environmental issues which require a holistic approach. This is necessary due to the complexity of the issues, the diversity of actors involved and the need to find coordinated and innovative solutions to the challenges.

The Commission adopted a phased approach in developing the strategies which involves at least :

- Stage 1: Definition of the problem (the “Towards Communication”)
- Stage 2: The strategy itself, including scenarios to address the thematic issues, the general objectives and specific targets, the means selected to achieve the objectives accompanied with their timetable and the relevant monitoring instruments.

The merit of the phased approach would be to reconcile the need to move on swiftly with the thematic issues while maintaining full opportunity for the European Legislators (European Council and European Parliament) and other European Institutions to influence the proposals.

As indicated above the Towards Communication (stage 1) was already subject to opinions of the European Council, the European Parliament, the European Social and Economic Committee and the Committee of the Regions.

Form and presentation of Thematic Strategies

The decision on the 6EAP leaves it up to the Commission to define the legal form of the strategies. The choice to be made can vary from one strategy to another and depends on the content of the strategy and the objectives to be reached.

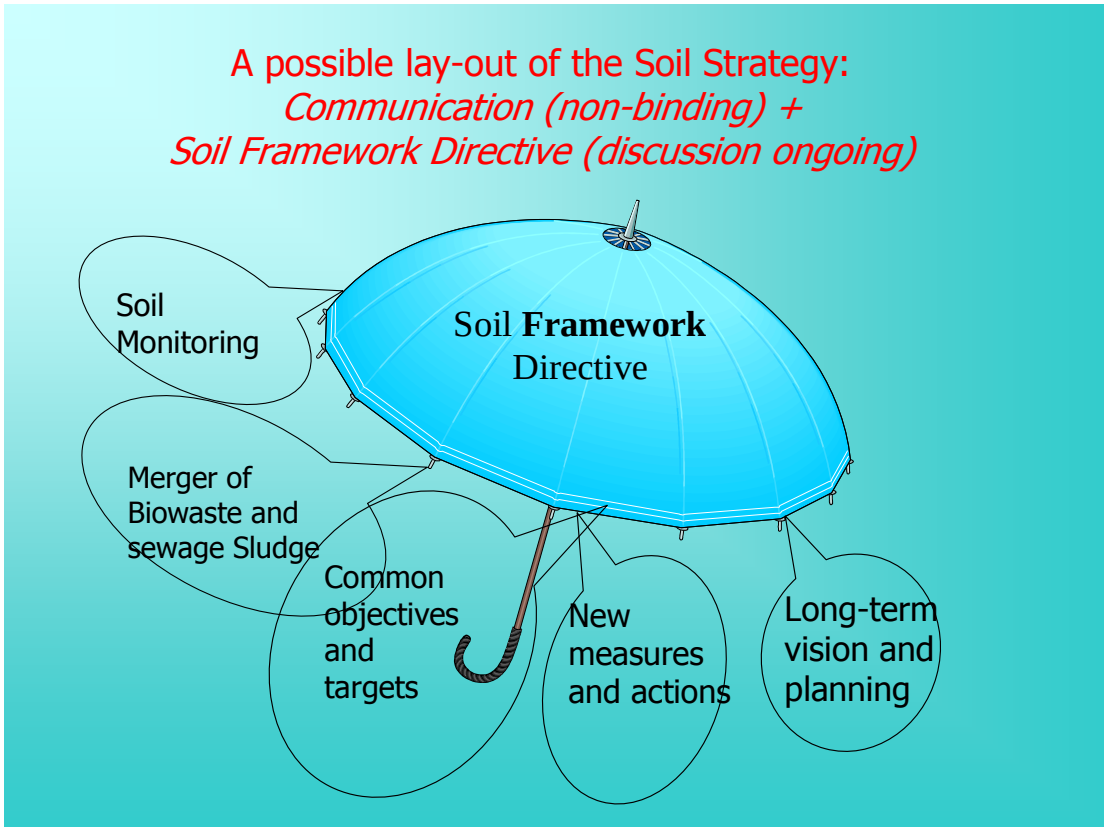
Each strategy will result in a package comprised of concrete proposals, or of announcements of proposals to come, and will contain (some of) the following elements:

- The overall policy approach chosen to address the issue
- The environmental aim to be achieved and the more specific objectives and targets to be pursued
- The specific measures proposed to reach the targets of each measure
- The monitoring mechanism to measure progress and evaluate effectiveness of the measures
- The timetable and associated responsibilities for implementation
- Thorough (Extended) Impact Assessments

The type of measures includes:

- Revision of existing provisions
- New legislation (regulation, directive), recommendations, guidelines, voluntary agreements
- Measures under environmental policies or measure under other Community policies

For the soil strategy the discussion on the final form is presently on-going. Non-binding elements are likely to be presented as a new (second) Communication. In case it is decided that binding measures are required they can be presented either as a Council Decision, as a Directive or as a Framework Directive.



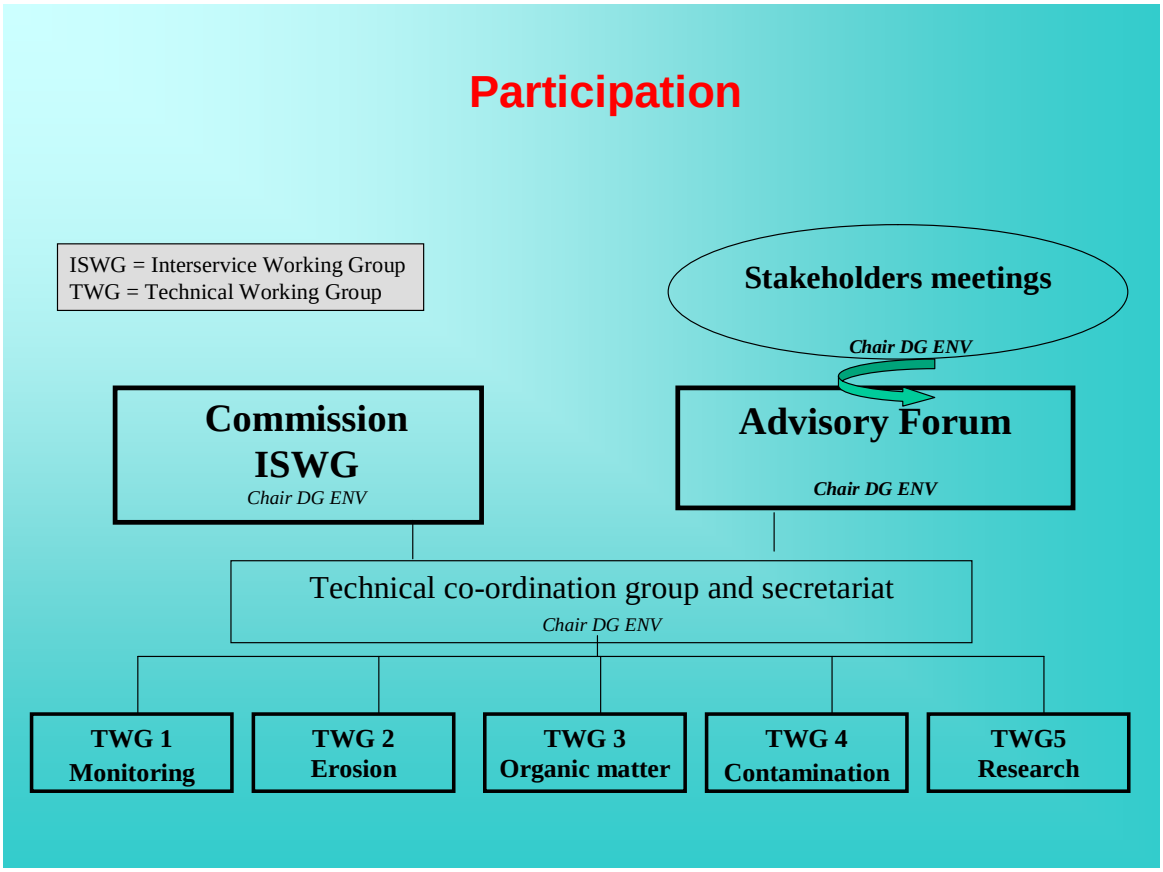
Participatory approach to soil policy making

Participative policy-making is at the core of the development of the Thematic Strategies for soil protection. Therefore an intensive process of active stakeholder involvement and consultation has been organised during 2003-2004 for the soil strategy. Five Working Groups and an Advisory Forum have been established. Working Groups developed technical guidance on key issues that have been previously outlined in "Mandates" and consolidated by the Advisory Forum. The Advisory Forum oversaw the activities of the Working Groups and expressed opinions on the assessments and reports of the Working Groups.

Members of Working Groups and Advisory Forum were representatives from:

- Member States and Candidate Countries
- European Commission Services and the EEA
- EU Institutions
- European Networks of regional and local authorities
- European-wide civil society organisations (Non-Governmental Organisations, Consumer Organisations, Professional Organisations, Organisations of Research and Academia, …)
- European-wide Organisations of Industry and Social Partners
- International Organisations

In total about 400 persons co-operated within the Technical Working Groups and the Advisory Forum. The Advisory Forum met 3 times in Brussels. Each of the Working Groups met 4-5 times across Europe. Outside the meetings members of Working Groups cooperated primarily by e-mail. The Working Groups were led by a total of 15 colleagues from Member States and major organisations.



Reports of the Technical Working Groups established under the Thematic Strategy for Soil Protection

The European Commission, Directorate General for Environment, provided the framework and guidance for the activities of the Working Groups which delivered their independent reports by May 2004. The reports have been compiled by members of the Technical Working Groups and represent their collective professional views. The Commission intends to draw on those reports when designing the final content of the soil strategy (stage 2) planned to be presented during 2005.

This publication presents the actual reports from the 5 Technical Working Groups that operated during 2003-2004 under the umbrella of the Thematic Strategy for Soils.

Volume I consists of the executive summaries from each of the five Working Groups.
Copy of the above indicated "mandates" are also included into volume I. These mandates were developed by the European Commission colleagues, consolidated by the stakeholder "Advisory Forum" and then passed on to the Technical Working Groups. The mandates form the basis for the activities of the Working Groups and outlined key issues where technical guidance was required.

Volumes II-IV present the entire reports (excluding enclosures) as developed by the Working Groups. Thanks to the large number of enthusiastic and competent participants in the Working Groups it has been possible to further delegate specific work packages and to constitute drafting groups or "Task Groups" within each of the 5 Working Groups. 31 Task Groups have been established and were led by Task Group Leaders. Volumes II-IV follow this structure of Task Group Reports.

The five reports on erosion, organic matter, contamination, monitoring and research can also be consulted at *http://forum.europa.eu.int/Public/irc/env/soil/home*

Although it has not been possible to cover all relevant soil issues to the same extent and despite of the fact that a number of questions remain unsolved, the added value of this unique volume of work is first and foremost situated in the fertile but sometimes unexplored area between soil science and policy making. Working Groups and Advisory Forum contributed significantly in bridging this gap between technical knowledge, professional interests, national views and the soil policy developments at European level. This effort has been successful thanks to the proactive and constructive attitude of the widest possible range of stakeholders, interested parties, states, networks, scientists and academics, all of them who participated enthusiastically within a European framework.

Lieve Van Camp

European Commission
Directorate General for Environment
Brussels, October 2004

FRAMEWORK MANDATE FOR ALL WORKING GROUPS

1. INTRODUCTION

The development of EU Soil policy can be divided into 3 phases:

- Phase 1: ending in 2002: past developments: leading to the "soil communication" ("towards" document, COM(2002)179 final)
- Phase 2: 2003-2004: present developments: leading to proposals on action and monitoring and focussing on 3 priority areas
- Phase 3: starting in 2005: future developments

The tasks in the framework of the working groups (WG) focuses primarily on phase 2. It takes into account the developments identified under phase 1 and includes as part of its mandate proposals for long-term development (phase 3).

2. GENERAL REQUIREMENTS

The final aim of the working groups is to contribute to the deliverables the European Commission is committed to:

- a proposal for a monitoring directive
- a communication on action in 3 priority areas (erosion, contamination, organic matter)
- directions for future research.

In this context working groups should equally contribute to a number of horizontal and cross-cutting issues of relevance to the development of the soil thematic strategy.

Therefore working groups should:

- carries out their tasks according to the provisions of :
  - Document 1 : Framework mandate
  - Document 2 : Co-ordination, working methods and common planning
  - Document 3 : Specific mandates.
- Use the soil communication (COM(2002)179final), the opinions of the EU institutions and the stakeholder contributions, as pillars for the tasks of the working groups. A large number of requirements and proposals originating from this set of documents have already been integrated in the mandates.

2.1. Policy requirements

Policy should be based on a number of requirements which have to be assessed by all WG among their tasks and which are detailed in annex 1:

1. Policy cycle
2. Formulation of the policy
   - 2.1. Policy based on knowledge and information
   - 2.2. Stakeholder participation
   - 2.3. Impact Assessment
   - 2.4. Choice of policy instruments
3. Soil protection and Sustainable use
   - 3.1. Sustainable use
   - 3.2. Socio-economic aspects
4. Basic principles
   - 4.1. Polluter-pay and the principle of preventive action
   - 4.2. Precautionary principle
   - 4.3. Principle of rectification of pollution at source
   - 4.4. Subsidiarity and proportionality principle
5. Gender mainstreaming

The "Thematic Strategy" approach to policy making requires an integrated and holistic approach.

2.2. Cross-cutting issues

A number of cross-cutting issues have been identified which have to be taken into account by all WG and which are detailed in annex 2.

During the development of the Soil Thematic Strategy, links are to be established with specific environmental areas, some of which are addressed in the Sixth Environmental Action Programme of the European Community.

1. Basic definitions
   - 1.1. Basic definition of soil
   - 1.2. Soil as an ecosystem
2. Climate change issues
3. Environment and health issues
4. Biodiversity issues
5. Role of land use planning policy
6. Role of agriculture and forestry in revitalising soil
7. Coordination with the world wide dimension
8. Awareness, Communication and Participation
   - 8.1. Awareness raising, dissemination, education and training
   - 8.2. Data requirements and format
   - 8.3. Participation of the public in implementation
9. Property rights related to soils and soil data

2.3. Tackling the eight soil threats

The soil communication identifies eight soil threats. Numerous linkages between each of the threats exist and the holistic nature of the Soil Thematic Strategy requires that soil be looked at as a single environmental medium.

Policy recommendations are to be defined for at least 3 priority areas:

- erosion
- contamination (local and diffuse)
- organic matter.

This task is supported by the three thematic working groups.

Other five "soil threats" have been identified for which no specific working groups have been foreseen: 1. Biodiversity, 2. sealing, 3. compaction and 4. floods and landslides and 5.salinisation

The Advisory Forum identified some relationships between these five threats and the three specific WG. These five soil threats have therefore been attached to WG as follows:

- erosion : compaction, floods and landslides, salinisation
- organic matter : biodiversity
- research : sealing

All eight threats have to be tackled within the horizontal working groups monitoring and research.

2.4. Specifications for the deliverables

A common structure for the report of the 3 thematic working groups is recommended based on the "DPSIR model" (Driving forces, Pressures, State, Impacts, Responses) which is explained more in detail in annex 3.

The use of this DPSIR model will facilitate the realisation of Extended Impact Assessment which has to be achieved for the Soil Thematic Strategy.

2.5. Common activities for all WG

Each WG should include in their deliverables the following items:

2.5.1. EU wide reporting of the state of soils

Working groups should base their activities on an analysis of the present state of the soil in the enlarged EU. This should including negative and positive pressures. An integrated joint report on the state of European soils will be realised with the contributions of the working groups and published by the European Environment Agency.

2.5.2. Basic typology and characterisation across European soils

Harmonised information throughout Europe is an important element for sound policy making. An inventory of soil resources based on a thematic cartography and a database linked to it should also allow an assessment of vulnerability to major soil threats.

The possibilities for the development and establishment of a basic soil typology, and characterisation of soil will allow to establish background or reference levels as an integral part of the policy formulation. This should be reflected upon in the working groups and further developed within the working groups for monitoring and research.

2.5.3. Soil legislative framework (soil framework directive)

The possibilities for a soil legislative framework should be explored, including the restructuring of current relevant EU legislation.

2.5.4. EU soil conservation service

Possibilities and potential for the establishment of a EU soil conservation service should be explored. Existing models should be explored and compared, such as the US Natural Resources Conservation Service.

Annex 1: Details on Policy requirements

1. THE POLICY CYCLE

- Problem definition: identifying and defining the problems to be addressed.
- Formulation of the policy to address the problem (including formulation of indicators to evaluate the policy)
- Implementation
- Evaluation of its effectiveness leading to
- Review and formulation of new policy.

The soil communication addressed the first step of the policy cycle i.e. problem definition. The problems identified can be further refined and adjusted during the present phase.

Step 2 is primarily concerned with formulation of the policy, and prepares for the next steps which are implementation and evaluation.

As part of the actions quantifiable targets and timetables should be established against which the implementation of the actions can be assessed and evaluated. The aim is to halt further degradation of soil status and to assure that soil can provide all its functions for human activities and ecological needs.

It should be possible to regularly assess and if necessary to adjust actions (when in place) to ensure that resource consumption is not preventing more promising initiatives to be developed. Therefore monitoring of actions has to be developed in parallel to those actions.

Prioritisation is a must given the finite resources available. Only most promising initiatives are to be developed following criteria to be agreed.

2. FORMULATION OF THE POLICY

2.1. Policy based on knowledge and information

The knowledge-based approach defined in the sixth environmental action programme (6EAP) requires that policies, at all stages of development, be based on best available knowledge and information.

However, this approach should not lead to action being retarded for reasons of information not being complete. Noting also that where there is threat of significant reduction in soil functions or soil loss, in situation where there is a lack of full scientific certainty, the precautionary principle has to be applied to avoid or minimise such a threat.

To assure that those decisions are as rational as possible it is essential to communicate all information, including uncertainties, in a transparent way.

Expert judgement plays an important role in decision making to make sense of information involving a high level of uncertainty.

2.2. Stakeholder participation

Stakeholder participation forms an essential part of all stages of the policy cycle. Participation should become part of the mainstream policy development process.

Interested parties should have a real sense of involvement without allowing policy to be unduly influenced by well-organised lobbies.

Final decision will be taken by the European Commission after consideration of the consolidated reports of the working group, in accordance with its right of initiative and then translated into concrete proposals in a transparent way.

2.3. Impact Assessment

An Extended Impact Assessment has to be achieved for the Soil Thematic Strategy following the Communication from the European Commission on Impact Assessment, adopted on 5 June 2002 (COM(2002)276final).

Impact Assessment identifies the likely positive and negative social, economical and environmental impacts of proposed policy actions, enabling informed political judgements to be made about the proposal and identify trade-offs in achieving competing objectives. It also permits to complete the application of the subsidiarity and proportionality protocol annexed to the Amsterdam Treaty.

Impact Assessment integrates all sectoral assessments concerning direct and indirect, short term and long term impacts of a proposed measure into one global instrument, hence moving away from the existing situation of a number of partial and sectoral assessments. It provides a common set of basic questions, minimum analytical standards and a common reporting format with a sufficient flexibility to accommodate the differences between Commission policies and to take into account the specific circumstances of individual policy areas.

The general process of Impact Assessment is explained in the Handbook of the European Commission in seven sections as presented in the figure 1.

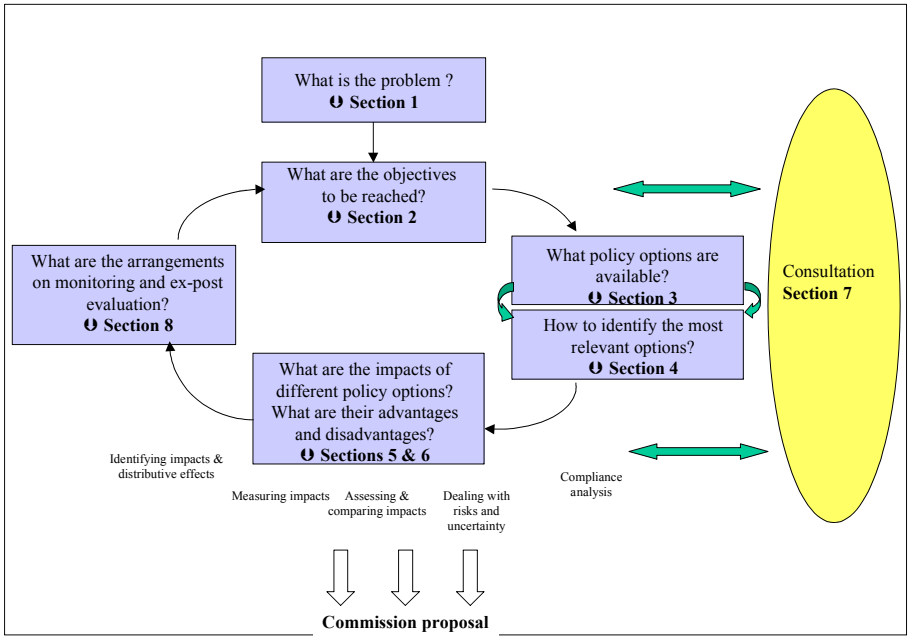


Figure 1. General process of Impact Assessment

In order to fulfil this Extended Impact Assessment, benefits as well as trade-offs of the policy options retained should be explained. This will lead to more robust proposals and to more widespread support. Supporting information should be made available to guarantee openness. Intended as well as unintended effects of the actions must be identified. An economic estimation of soil losses has to be achieved.

Base-case scenarios are to be developed as reference scenario in order to predict situations if no action is taken.

2.4. Choice of policy instruments

When defining actions full consideration should be given to the full range of policy instruments available to implement action in the most cost-effective and efficient manner. This includes reinforcement of existing environmental instruments and integration into existing policies.

The range of policy instruments considered should be broadened to include market based instruments, awareness raising and land-use planning (6EAP).

3. SOIL PROTECTION AND SUSTAINABLE USE

Soil strategy is both about soil protection and its sustainable use. Sustainable use is defined in the Sustainable Development Strategy.

Protection of soil and sustainable use of its components should aim at a fair and equitable sharing of the benefits arising out of its utilisation.

3.1. Sustainable use

Sustainable use means the use of resources and components of the environment in a way and at a rate that preserves at the long-term its multitude of functions and preserves or improves its quality, thereby maintaining its potential to meet the likely needs and aspirations of present and future generations.

Soil performs indeed a multitude of key environmental, economic, social and cultural functions, vital for life:

- Food and other biomass production: Food and other agriculture production, essential for human survival, and forestry are totally dependent on soil. Almost all vegetation including grassland, arable crops and trees, need soil for the supply of water and nutrients and to fix their roots.
- Storing, filtering and transformation: Soil stores and partly transforms minerals, organic matter, water and energy, and diverse chemical substances. It functions as a natural filter for groundwater, the main source for drinking water, and releases CO_2, methane and other gases in the atmosphere.
- Habitat and gene pool: Soil is the habitat for a huge amount and variety of organisms living in and on the soil, all with unique gene patterns. It therefore performs essential ecological functions.
- Physical and cultural environment for mankind: Soil is the platform for human activity and is also an element of landscape and cultural heritage.
- Source of raw materials : Soils provide raw materials such as clay, sands, minerals and peat.

3.2. Socio-economic aspects

Socio-economic aspects and data are an integral part of the knowledge base when policy is defined. Cost-effectiveness and cost-benefit analysis are to be taken into account as much as the social side, in particular during policy formulation. Cost-benefit analysis should ensure that the actions proposed are worth the costs they are bringing with them. Cost-benefit analysis also applies to monitoring activities.

"Downstream effects" are to be internalised within the costs-benefit analysis. This will also contribute to awareness raising. Certain benefits may be difficult to quantify, to assess and to attach an economical value to, such as the beauty of a landscape, rich biodiversity or human health.

Broader benefits of soil conservation including its potential contribution to habitat creation, promotion of bio-diversity, and carbon sequestration should be recognised.

4. BASIC PRINCIPLES

4.1. Polluter-pay and the principle of preventive action

Community environmental policy should be based upon certain basic principles among which the polluter pays principle and the principle of preventive action. One of the important tasks for the Community is to ensure that those who cause injury to human health or cause damage to the environment are held responsible for their actions and that such injury and damage is prevented whenever possible.

4.2. Precautionary principle

The resolution of the Council considers that use should be made of the precautionary principle where the possibility of harmful effects on health or the environment has been identified and preliminary scientific evaluation, based on the available data, proves inconclusive for assessing the level of risk.

4.3. Principle of rectification of pollution at source

Actions should address the problems of soil pollution and degradation at source rather than tackling the issue further down in other environmental compartments where impacts are observed.

4.4. Subsidiarity and proportionality principle

Soil has a strong local component due to its high natural variability. The EU should take a prominent role in areas where it can deliver an added value compared to individual Member States' actions. The form of Community action shall be as simple as possible, consistent with satisfactory achievement of the objective of the measure and the need for effective enforcement.

5. GENDER MAINSTREAMING

Gender issues are reflected upon by the working groups and integrated into the policy development from the first steps of policy development. Particular attention must be given to risk groups such as pregnant woman and infants.

Annex 2 : Details on cross-cutting issues

1. BASIC DEFINITIONS

1.1. Basic definition of soil

Soil is generally defined as the top layer of the earth's crust. It is formed by mineral particles, organic matter, water, air and living organisms. Soil is the interface between the earth (geosphere), the air (atmosphere) and the water (hydrosphere), in continuous evolution in a time schedule. It is the basis for different functions (listed under point 3.1 of Annex 1).

Furthermore, soil should be regarded as a four dimensional body (time being the fourth dimension) in its widest possible sense, covering the entire land surface, excluding the water (and ice) surfaces but including the sediments which could be regarded as representing the youngest phase of the soil. Possible overlaps with the water framework directive and coastal areas have to be considered.

The Soil Thematic Strategy is not limited to a particular use, it includes the widest range of possible land uses: agriculture, forestry, urban, industry, tourism, infrastructure, etc.

A distinction between – soil – land – land use – land use planning is to be made within the specific context of the Soil Thematic Strategy.

1.2. Soil as an ecosystem (development of guidelines)

The soil ecosystem approach is an integrated approach implementing the sustainable development strategy. Ecosystem means a dynamic complex of human, plant, animal and micro-organism communities and their non-living environment interacting as a functional unit. The ecosystem approach addresses both human and ecological well-being. The ecosystem approach recognises the interdependence between both.

An ecosystem approach to soil intends to balance diverse societal objectives by taking into account the knowledge and uncertainties about biotic, abiotic and human components of ecosystems and their interactions, and applying an integrated approach to land use within ecologically meaningful boundaries. It is important to raise awareness on the interactions between land uses and the soil (terrestrial) ecosystems within which they exist, and to establish guidelines for the implementation of the approach.

2. CLIMATE CHANGE ISSUES

Forecast suggest that climate change will result in temperature rises of between 1° and 6° by 2100 resulting in sea level rises up to 90 centimetres and significant changes in weather patterns such as increased droughts, floods, cold spells and severe storms. In Europe significant consequences are forecasted for agriculture, forestry, tourism, water supplies and biodiversity. Some of those elements are already under major pressure for a diversity of reasons. The implications for society world-wide can be devastating.

Soils are expected to be affected directly: a soil is formed by climatic conditions and changing climate conditions will change some of its intrinsic characteristics. But soils are also affected indirectly through a variety of impacts of climate change on land use, ecosystems, agriculture, forestry, erosion, droughts, floods, water and groundwater supplies.

Soils are not only affected by the impacts of climate change, they are equally a source and potentially a sink for organic carbon. Soils, depending on the way they are managed, can be a contributor to greenhouse gas emissions: for example nitrous oxide emissions from agricultural soils, methane emissions from landfills. Deforestation and land use changes can importantly contribute to the release of carbon dioxide in the atmosphere. Conversely, the potential of the "soil as a carbon sink" has been internationally recognised: it is possible to reduce the concentration of carbon dioxide in the atmosphere by locking-up carbon in soils and land use (biomass, forests) by changing land use patterns and practices[1].

3. ENVIRONMENT AND HEALTH ISSUES

A number of soil issues are linked to health and therefore it is reasonable to assume that an enhanced soil protection will be reflected in improvements of the environment and public health in general.

Certain contaminants and pathogens could remain in the soil for example when unstabilised sludge or compost are spread on land. Potential impacts on health may occur through ingestion (bio-accumulation in the food chain) or through direct contact (for exposed workers and children during recreational activities). Wind erosion generates also fine particles, which could have negative impacts on some sensitive groups.

In conclusion, the working groups ought to address the links between soil and human health as a way of improving the latter and building up soil-related awareness in the public opinion.

4. BIODIVERSITY ISSUES

The Soil Thematic Strategy is one of the priority actions identified in the Sixth Environmental Action Programme

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[1] "European Climate Change Programme (ECCP) Working Group report on carbon sequestration in agricultural soils": http://europa.eu.int/comm/environment/climat/agriculturalsoils.htm

"Increasing carbon stocks in French agricultural soils "(Institut National de Recherche Agronomique, France): http://www.inra.fr/actualites/rapport-carbone.html

of the European Community that should contribute to the biodiversity objective: "*protecting, conserving, restoring and developing the functioning of natural systems, natural habitats, wild flora and fauna with the aim of halting desertification and the loss of biodiversity, including diversity of genetic resources, both in the European Union and on a global scale*".

Healthy and balanced natural systems are essential for supporting life on this planet. The species living and evolving in the soil are contributors to the Nitrogen cycle, Carbon cycle, etc. But we also value nature for its own sake, as a provider of services and as a source of scientific interest.

Pressures originate from pollution, which can be sudden and local or build up slowly over time, for instance eutrophication and acid rain that wears down soils, forests and lakes. Pressure is also coming from changes in land use practices, over-exploitation of resources and fragmentation of the countryside due to infrastructure and development. Just to quote some figures, in North and Western Europe some 60% of wetlands have been lost and in Southern Europe forest fires further contribute to the pressure on natural and semi-natural ecosystems and their biodiversity. Furthermore, forecasts suggest that the impacts of climate change will further exacerbate the pressures on biodiversity.

Much of Europe's landscape and semi-natural environments are a result of our land use and farming heritage. Hence maintaining valuable landscapes requires appropriate land management activities.

Soil biodiversity is increasingly an issue of research and evidence demonstrates that a larger and wider diversity is present in the soil than on the soil. Biodiversity and in particular soil biodiversity could be used as an indicator for the "well-being" of the soil (soil quality and good status of soil) and the terrestrial ecosystems of which human beings are an integral part.

5. ROLE OF LAND USE PLANNING POLICY (SOIL SUITABILITY, SOIL CAPACITY AND LAND EVALUATION)

Land use planning policy should relate land use to soil capacity because loss of soil is irreversible for example when extending the urban environment. Soil sealing should take protection of the soil resources into account. Co-ordination between different sectoral policies in this area is required. In particular, synergies should be developed with the upcoming urban thematic strategy and with the communication on planning and environment.

Rules should be established to bring land use in line with soil characteristics and land/soil suitability. It should be ensured that suitable soil use is a basic factor in soil conservation and sustainable use.

6. ROLE OF AGRICULTURE AND FORESTRY IN REVITALISING SOIL

Agriculture and forestry can play an important role in revitalising soil and those possibilities should be explored.

Indeed, farming methods should be adapted to the soil characteristics: good land use is based on good practices and appropriate use of soil resources and soil suitability within a socio-economic context.

A typology of agricultural land and related good farming practices could be established and this concept can be widened to all major land uses and beyond the agricultural use.

Possibilities of existing forestry and agricultural instruments, including cross-compliance and the agricultural first pillar should be explored for implementing actions in the field of erosion, organic matter and contamination.

In this context, it should be explored how to render more effective the agri-environment and forestry programmes to give incentives for soil conservation practices and support crops suitable for the soil and the socio-economic situation. Wider options for farmers and foresters should also be developed for these programmes. Specific aspects of the mid-term review and their effect on soil conservation can be considered in this context such as non-rotational set aside, decoupling, etc.

There is a need for industry, academia, farmers, foresters and agencies to work together to provide solutions to agriculture and forestry, for example concerning the role of agro-chemicals in responding to erosion and organic matter depletion.

7. CO-ORDINATION WITH THE WORLD-WIDE DIMENSION

Soil protection and sustainable use at a European level must be placed in its worldwide and international context.

In particular, co-ordination between the organic matter and erosion working groups with the desertification issues (UNCCD) and existing initiatives is to be established and efforts are to be co-ordinated to obtain maximum benefit. Soil erosion and organic matter are fundamental factors of concern in desertification.

8. AWARENESS, COMMUNICATION AND PARTICIPATION

8.1. Awareness raising dissemination, education and training

The Working Groups will identify and recommend measures to raise awareness on soil as a common and valuable resource. The general public, local, and national administrations and all stakeholders have to be addressed. Awareness should be increased through education, training, information, dissemination and demonstration.

8.2. Data requirements and format

The sixth environmental action programme puts considerable emphasis on the necessity to create a better information base for environmental policy. Data requirements should be part of a common, shared information system and focus on principles relevant to multi-purpose use of the same data and orderly dissemination to a wider audience.

The requirements of the new (horizontal) proposal for reporting, the INSPIRE (infrastructure for spatial information in Europe) and GMES (global monitoring for environment and security) proposals are to be taken fully into account.

8.3. Participation of the public in implementation

Public and all interested parties could be involved during the implementation phase. Existing systems such as the Australian land care system could be used as a model.

9. PROPERTY RIGHTS RELATED TO SOIL AND SOIL DATA

Situations in member states with respect to property rights on soil and land should be analysed. Property situation may vary largely between soil and water surfaces and from one state to another. Property of a surface (two-dimensions) does not necessarily imply property over the soil, which is a three-dimensional entity. A distinction should be made between ownership rights and use rights. Use rights should be defined and made explicit.

Annex 3: DPSIR analytical framework

The Driving forces - Pressures - State - Impact - Responses (DPSIR) framework can be used to explore the relations between human activities and the environment (see figure 2). The DPSIR is a slightly extended version of the well-known OECD-model and is used by EEA and other organisations to make assessments on and characterise the main environmental issues, such as climate change, acidification, soil degradation and wastes.

According to this systems analysis view, social and economic developments exert pressure on the environment and, as a consequence, the state of the environment changes. This leads to impacts on e.g. human health, ecosystems and materials that may elicit a societal response that feeds back on the driving forces, on the pressures or on the state or impacts directly, through adaptation or curative action.

From a policy point of view, there is a need for clear and specific information on all DPSIR elements. The DPSIR can be used for example, to identify sets of indicator to communicate the most relevant features of the environment and other issues included in the assessments and policy analyses. In order to meet this need, environmental indicators and policy analyses should reflect all elements of the chain between human activities, their environmental impacts, and the societal responses to these impacts.

Although it is possible to look at the DPSIR framework as a descriptive analysis with a specific focus on individual elements in the economic, social and environmental system, it is the relationships between the elements that introduce the dynamics into the framework, and bring about changes.

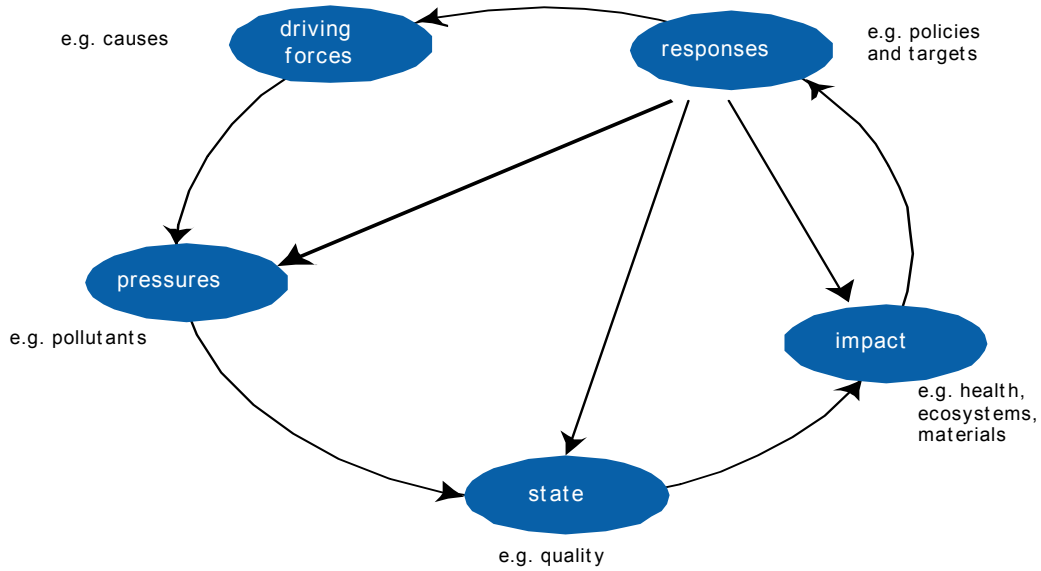

Figure 2. The DPSIR framework for reporting on environmental issues

The existence of these interrelations also shows that the DPSIR framework, although often presented as a linear chain or a circle, in fact resembles a very complex web of many interacting factors. In many cases the change in the state of the environment or impacts has several causes, some of which may be immediate and of local origin, others may be exerting their influence on a continental or even global scale. Reductions in pressures often result from a mixture of policy responses and changes in various driving forces.

CO-ORDINATION, WORKING METHODS AND COMMON PLANNING

1. ADVISORY FORUM

1.1. Role

The Advisory Forum is established to guide the soil policy development process. The Advisory Forum will:

- co-ordinate and oversee the work of the different Working Groups
- monitor the implementation of the work-plan
- give guidance on key issues
- assess and evaluate the output from the various working groups.

1.2. Members

Members of the Advisory Forum are representatives from:

1. Member States and Accession Countries,
2. European Commission Services, Joint Research Centre, European Environmental Agency,
3. EU Institutions
4. European networks of regional and local authorities,
5. European-wide Civil Society Organisations and major networks:
   Non-Governmental Organisations, Consumer Organisations, Professional Organisations, Organisations of Research and Academia, …
6. European-wide organisations of Industry and Social Partners
7. International organisations

The maximum number of representatives for each of the countries/organisations listed under point 1.2 above is two.

1.3. Chair

The European Commission, Directorate-General for Environment, chairs the Advisory Forum.

1.4. Selection of Members

- Member States and Candidate Countries appoint a maximum of two representatives and communicate their decision to the European Commission.
- The European Commission services, the Joint Research Centre, the European Environmental Agency and the EU institutions are invited to participate in the Advisory Forum.
- The chairs and co-chairs of the Working Groups are equally invited to participate in the Advisory Forum.
- Representatives from the "broader stakeholder community" defined under (4)-(7) above should also be represented in the Advisory Forum. Therefore those organisations are invited to apply for participation in the Advisory Forum.

The European Commission will evaluate all applications from those organisations received within the deadline, and will decide on their participation based on the following criteria:

- o Level of representation
- o European character
- o Specific expertise

1.5. Working methods for the Advisory Forum

The purpose of the first meeting of the Advisory Forum is the formal establishment of the Forum itself and the consolidation of the mandates for the working groups.

The Second and third meetings of the Advisory Forum will be primarily dedicated to the discussion and consolidation of the interim and final reports of the groups.

The Advisory Forum aims at reaching consensus on a maximum number of issues but has also to reflect differences in opinions. The Forum evaluates the results from the working groups and may establish priority lists of options and solutions proposed by the working group. In this context the Forum may advice the working groups to explore alternative possibilities and approaches.

For urgent matters in between meetings written procedures (by electronic mail) will be used.

2. TECHNICAL WORKING GROUPS

2.1. Role

A structure of five working groups is being established. Three working groups address specific soil threats and two have a more general scope covering soil monitoring and research.

Therefore two types of working groups can be distinguished.

- 3 *thematic* working groups: they focus on policy actions related to three priority areas: erosion, contamination and organic matter.
- 2 *horizontal* working groups: one on monitoring and one on research

Working groups should develop technical guidance on key issues previously outlined in a specific "mandate" which has been previously consolidated by the Advisory Forum. The Advisory Forum should evaluate the outcome of the working groups and base its opinion on the assessment by the working group.

Strong co-ordination and planning between the groups is required and will be ensured by the European Commission to lead to a corporate and integrated result as required by the thematic strategy approach.

2.1.1. Actions and the links to monitoring

Actions and monitoring are intrinsically linked: actions are formulated to address the problems that have been identified, while monitoring assesses the effectiveness of those actions and contributes to the evaluation and review of the policy.

Monitoring within the soil strategy also serves as a tool to complete data gaps and needs of relevance to the policy. It is therefore useful to distinguish two types of monitoring:

- **Action-driven monitoring**
  (monitoring in the strict sense). This type of monitoring follows directly from the policy actions

and has the objective to assess the effectiveness of the actions.

- **Multi-purpose monitoring**

  (monitoring in the large sense). This type of monitoring serves to complete and update knowledge and information on the environment of relevance to soil policy. This monitoring is not strictly related to policy actions but serves in the longer term to increase the "knowledge-base" for the policy.

The working group on monitoring deals primarily with multi-purpose monitoring. In this context multi-purpose monitoring should aim at comprehensive soil protection, and create a harmonised and basic data system for the soil strategy.

Action-driven monitoring follows directly from the formulation of actions and should be developed in parallel with the action.

Multi-purpose monitoring should allow sufficient flexibility to accommodate specific action related monitoring at a later stage.

Therefore strong co-ordination between monitoring and the formulation of actions is required.

2.1.2. Actions, monitoring and the links to research

The discussions held in the thematic working groups and in the monitoring working group will lead to the identification of medium and long-term gaps in data and knowledge. These identified gaps ought to be referred to the research working group for their assessment. This working group will analyse if they should be the subject of further research.

While recognising that the availability of relevant information will vary widely among countries, considerable relevant information is nonetheless available. Although there is a lack of knowledge concerning certain soil aspects, uncertainty must not prevent the development of operational goals based on best available knowledge.

Therefore a start on actions and monitoring should be made now and should be based on existing knowledge. Future research is however also needed and constitutes the specific mandate of the research working group.

2.1.3. Co-ordination between working groups

In order to ensure co-ordination and coherence between the working groups:

- Chairs and/or co-chairs of the thematic working groups participate in the meetings of the horizontal working groups (monitoring and research)
- Planning and agenda's of the meetings of the working groups is established in consultation with DG Environment
- Chairs and co-chairs meet with DG Environment at regular intervals (every 6-8 weeks) according to a detailed planning to be established. These meetings are chaired by DG Environment (co-ordination meetings).
- DG Environment participates at all meetings of the working groups and assists in steering the working groups to obtain the required results.

2.2. Members

Members of the Working Groups are representatives from:

1. Member States and Accession Countries,
2. European Commission Services, Joint Research Centre, European Environmental Agency,
3. EU Institutions
4. European networks of regional and local authorities,
5. European-wide Civil Society Organisations and major networks:
   Non-Governmental Organisations, Consumer Organisations, Professional Organisations, Organisations of Research and Academia, …
6. European-wide organisations of Industry and Social Partners
7. International organisations

One representative per working group is foreseen for each of the countries/organisations listed under point 2.2.

In order to obtain a workable size, the maximum number of members should be in the order of 30, next to the European officials and chairs/co-chairs.

2.3. Chairs/co-chairs

Working Groups can be chaired by:

- A Member State
- A European Commission service, the Joint Research Centre, the European Environmental Agency

Working Groups can be co-chaired by:

- A Member State
- An Accession Country
- A European Commission service, the Joint Research Centre, the European Environmental Agency
- A major organisation under (4)-(7) above

Interested countries/organisations listed under point 2.3 have been invited to apply for the chairs and co-chairs.

The European Commission evaluates the applications for chairs and co-chairs received within the deadline and decides on the final attribution.

2.3.1. Attribution

MONITORING	1. Joachim Woiwode (joint chair, Germany) 2. Luca Montanarella (joint chair, European Commission, Joint Research Center) 3. Peter Loveland (co-chair, United Kingdom)
CONTAMINATION	4. Sigbert Huber (joint chair, Austria) 5. Joop Vegter (joint chair, The Netherlands) 6. Anna Rita Gentile (co-chair, European Environmental Agency)
EROSION	7. Victor Castillo Sánchez (joint chair, Spain) 8. Liesbeth Vandekerckhove (joint chair, Belgium) 9. Rob Jarman (co-chair, European Environmental Bureau)
ORGANIC MATTER	10. Michel Robert (chair, France) 11. Stephen Nortcliff (joint co-chair, International Union of Soil Sciences) 12. Elise Bourmeau (joint co-chair, Fédération Européenne des Activités du Déchet et de l'Environnement)
RESEARCH	13. Jürgen Büsing (joint chair, European Commission, DG RTD) 14. Winfried Blum (joint chair, personal capacity) 15. Thierry de l'Escaille (co-chair, European Landowners' Organisation)

2.3.2. Role

Principal roles/tasks for the chairs/co-chairs of the Working Groups are, in close consultation and co-operation with the European Commission, Directorate-General for Environment:

- Organisation of meetings: invitations, meeting places and rooms, etc.
- Facilitator of the discussions and activities
- Development of a work-plan and a division of labour to be agreed by the working group and in accordance with their specific mandate
- Overall responsibility for the production of the deliverables (reports etc) according to the deadlines agreed in the work-plan. (while the work may be divided between different participants in the working group, the chair has the overall responsibility for delivery, on time and according to standard)
- Co-ordination with the Advisory Forum
- Presentation of the Working Group's results in the Advisory Forum.

2.4. Selection of Members

- Member States and Candidate Countries appoint one representative and communicate their decision to the European Commission.
- The European Commission services, the Joint Research Centre, the European Environmental Agency and the EU institutions are invited to participate in the Working Groups.
- Representatives from the "broader stakeholder community" defined under (4)-(7) above should also be represented in the Advisory Forum. Therefore those organisations are invited to apply for participation in the Advisory Forum.
- The European Commission will evaluate all applications from those organisations received within the deadline, and will decide on their participation based on the following criteria:
    - o Level of representation
    - o European character
    - o Specific expertise
- Final composition of the working groups will be annexed to each of the working group mandates
- Members are permanent members and changes have to be authorised by the European Commission.

2.5. Working methods for the working groups

Chairs and co-chairs represent the working group's views and results, rather than positions from states or organisations.

In many cases several answers to the same questions may exist. Therefore working groups should reflect expert opinions even when in disagreement. All options and recommendations presented will have to be accompanied by the advantages and disadvantages of such choices.

The main task for the chair is to facilitate and stimulate the debate in the working group. The chairs and co-chairs therefore take the role of moderator and facilitator.

A member in the group should represent the opinion of the state/organisation to which the chair or co-chair belongs. Therefore the state/organisation which takes up a chair or co-chair can have, in addition, a member in the group.

3. CO-ORDINATION BETWEEN THE ADVISORY FORUM AND THE WORKING GROUPS

Co-ordination between the Advisory Forum and the Working Groups is chaired by DG Environment and achieved through:

- Discussion and consolidation of the mandates in the Advisory Forum.

- Chairs and co-chairs participate at the meetings of the Advisory Forum. Chairs and co-chairs are not counted as state/organisation representation in the Advisory Forum. They have to represent exclusively the working groups results and positions.
- Chairs and co-chairs report on the development of the working group tasks in the Advisory forum.
- Advisory Forum discusses interim and final reports and consolidates them.

4. DELIVERABLES OF THE WORKING GROUPS

Each of the Working Groups drafts a report synthesising the outcome of the different tasks listed above by end January 2004 (draft final reports).

Interim reports will be elaborated by October 2003, which will be the subject of the second meeting of the Advisory Forum.

The draft final reports will be discussed during the third meeting of the Advisory Forum. Working groups finalise the report after this meeting. Final reports should be available by February 2004.

The reports will follow a common structure based on the "DPSIR model" as explained in the framework mandate. The reports will have a stand-alone character and will contribute to the development of the new Communication on action in 3 priority areas, the proposal for a monitoring directive and directions for future research.

Reports will have a wide distribution through the web site of DG Environment and the CIRCA repository. Reports may also be published in part or entirely.

5. WORK-PLAN

The kick-off meeting of the Working Groups will take place during May-June 2003. The Working Groups ought to fulfil the tasks and discussion related to the mandate by January 2004.

The Working Groups will meet *at least* three times in 2003 and once in 2004.

Within this time framework, the actual dates of the meeting will be left to the discretion of the chairs and co-chairs of the Working Groups who should propose several options to the members of the Group and co-ordinate the detailed planning with the European Commission.

The co-ordination group (chairs, co-chairs and European Commission) meets every 6-8 weeks on average. Apart from the meeting listed below this group will also meet in the margin of the meetings of the Advisory Forum.

Calendar, indicating the minimum set of meetings required:

- First meeting of the Advisory Forum: April 2003
- First meeting of the working groups: May 2003
- First co-ordination meeting (working group chairs and co-chairs): June 2003
- Second meeting of the working groups: August-September 2003
- Second co-ordination meeting: September 2003
- Second meeting of the Advisory Forum: discussion on interim reports: October-November 2003
- Third meeting of the working groups: November-December 2003
- Third co-ordination meeting: December 2003
- Third meeting of the Advisory Forum: discussion on draft final reports: January-February 2004
- Final meeting of Working Groups and Advisory Forum: March-April 2004.

6. GENERAL INFORMATION RELATED TO PARTICIPATION IN ALL WORKING GROUPS AND ADVISORY FORUM

6.1. Meeting place and frequency of meetings

The first meeting of the Advisory Forum has taken place in Brussels in April 2003. Subsequent meetings may take place in Brussels or in any of the Member States who volunteer to host the meeting. Two meetings are foreseen during 2003, the third meeting will be held at the beginning of 2004.

The meetings of the Working Groups can take place in any Member State. They are organised by the chairs/co-chairs in consultation with the European Commission, Directorate-General for Environment. The number of meetings foreseen is in the order of 3-5 during 2003.

6.2. Languages

The European Commission will provide for interpretation for meetings of the Advisory Forum that take place in Brussels. The basic language regime that is foreseen for interpretation is:

- Speaking and listening in the three working languages: English, French and German,
- Speaking in Italian and Spanish (interpretation of Italian and Spanish into those three working languages).

It is possible that on occasion this language regime may need to be modified due to constraints outside the control of DG ENV.

The working language of the Working Groups will be primarily English. The European Commission does not foresee interpretation for the Working Groups. It is therefore essential that members of the Working Groups can express their views adequately in English.

Working documents for all groups will typically be in English. A limited number of translated documents can be provided in selected cases when specific needs arise.

6.3. Geographical balance

During the evaluation of applications, the European Commission will take into account the need for a balanced geographical representation.

6.4. Cost related to participation

All participants in Working Groups and Advisory Forum are required to cover their own expenses related to their participation.

7. CONTACT INFORMATION AT THE EUROPEAN COMMISSION- DG ENVIRONMENT

7.1. Working Groups

Working group	Contact Information
Erosion: Action and input into monitoring and research	Benilde Bujarrabal Benilde.Bujarrabal-Fernandez@cec.eu.int
Contamination: Action and input into monitoring and research **Monitoring**: Co-ordination	Claudia Olazabal Claudia.Olazabal@cec.eu.int
Organic matter: Action and input into monitoring and research **Research**: Co-ordination	Lieve Van Camp Lieve.Van-Camp@cec.eu.int

7.2. Advisory Forum

Organisation/co-ordination: Lieve Van Camp

7.3. Soil thematic strategy

Secretariat: Cristina Diaz Dupon ,

Env-soil@cec.eu.int

Co-ordination: Lieve Van Camp

Head of unit: Patrick Murphy (DG ENV.B1 Water, Marine and Soil)

8. SOIL INTERNET SITE

http://europa.eu.int/comm/environment/soil/index.htm

9. SOIL CIRCA SITE – ELECTRONIC LIBRARY AND DISCUSSION SITE

The CIRCA system for the Soil Policy Interest Group is an electronic tool for exchanging information on the development of the policy. It facilitates the work of the different groups under the soil strategy. It is an electronic repository and library that allows the European Commission Services to communicate with the Public, share different types of documents, exchange views and data on the development of Soil Policy.

There are two levels of access: one for the general public http://forum.europa.eu.int/Public/irc/env/Home/main) and another for the members of the Working Groups and the Advisory Forum (via login and password, which will allow them to access other sections of the CIRCA-soil).

SPECIFIC MANDATES

1. INTRODUCTION

In the 6th Environment Action Programme (EAP) (Decision 1600/2002/EC of the European Parliament and of the Council of 22 July 2002 laying down the Sixth Community Environment Action Programme, OJ L242, 22.07.02, p.1) among the priorities set for the conservation of biodiversity and natural resources, the Community took the commitment of addressing soil alongside water and air as an environmental media to be preserved and to develop a Thematic Strategy for Soil Protection. Indeed, it has been agreed that as soil is a finite resource, the Community ought to aim at a sustainable use of the soil, with particular attention to preventing *inter alia* pollution, erosion, desertification, land degradation, land-take and hydrogeological risks taking into account regional diversity, including specificities of mountain and arid areas.

As a follow up to the adoption of the 6th EAP, the Commission adopted on 16 April 2002 a Communication (COM(2002) 179 final) towards a Thematic Strategy for Soil Protection. On that basis the Commission committed itself to build on actions that will lead to the improvement of the protection of soils. Among these actions, the Commission announced that

- a Communication would be adopted by mid 2004,
- a proposal for a Directive on monitoring of soils would be adopted by mid 2004.

Knowledge-based approach is a fundamental requirement for policy making highlighted in the 6th EAP. Research as an information and knowledge base to policy fulfils a key role in the soil thematic strategy. Therefore a working group on research has been established with the main purpose of facilitating transfer of information between researchers and policy makers, and identifying short term, medium term and long term research needs for soil.

In line with the participation requirement, the Commission aims at carrying out a broad consultation involving all stakeholders, which has been the foundation of the structure of Working groups and the Advisory Forum.

2. ORGANISATION, TASKS AND MANDATES OF WORKING GROUPS UNDER THE THEMATIC STRATEGY FOR SOIL PROTECTION

The specific mandates of the working groups are detailed in the annexes 1 to 5:

Annex 1: Contamination mandate
Annex 2: Erosion mandate
Annex 3: Organic matter mandate
Annex 4: Monitoring mandate
Annex 5: Research mandate

A list of acronyms of organisation names is provided in annex 6:

Annex 6: List of acronyms of organisation names

Annex 1 : Contamination mandate

1. INTRODUCTION

The introduction of contaminants in the soil may result in damage to or loss of some or several functions of soils and possible cross contamination of water. To assess the potential impact of soil contaminants, account needs to be taken not only of their concentration but also their environmental behaviour and the exposure mechanism for human health and for all types of ecosystems as well as the possible impact on food safety and exposure through ingestion and direct contact.

Local (or point source) contamination is generally associated with mining, industrial facilities, waste landfills and other facilities both in operation and after closure. Estimates of the number of contaminated sites in the EU range from 300 000 to 1.5 million. The European Environment Agency has estimated the total costs for the clean-up of contaminated sites in Europe to be between EUR 59 and 109 billion.

Diffuse pollution is generally associated with atmospheric deposition, certain farming practices and inadequate waste and wastewater recycling and treatment. Atmospheric deposition (including N-deposition) and acidification is due to emissions from industry, transport, households and agriculture.

Farming production systems may result in the contamination of ground- and surface water. Additional problems relate to heavy metals (e.g. cadmium, copper) in fertilisers and animal feed, to antibiotics and to pesticides. Sewage sludge may be contaminated by a range of pollutants, poorly biodegradable trace organic compounds and eventually pathogenic organisms.

The effects of diffuse soil contamination eventually result in breakdown of the buffering capacity of soil and in additional costs for water treatment due to organic compounds, pesticides, plant nutrients and heavy metals.

2. PROBLEMS IDENTIFIED

The Communication identified the following issues pertaining to the contamination of soils:

- the difference between local pollution and diffuse pollution
- the absence of a common and harmonised definition of contaminated site
- the lack of comparable and comprehensive information on the current status of contamination across Europe
- the very high number of contaminated sites (an estimate of 750.000 sites in the EU can be found in literature[1])
- the high costs of remediation of contaminated sites
- the necessity of preventive actions to avoid future contamination and corrective actions to remediate existing contamination
- the difference between historical and future pollution

Other institutions and stakeholders, which have expressed an opinion[2], highlighted additional major issues:

- the wide diversity of soil characteristics and problems
- the accumulation of chemicals in soils
- the importance of a pragmatic and local risk-oriented and cost-effective programme of protection
- the suitability of using a "fit for use" approach to contamination which would take into account inter alia food security
- the need to combine regulatory measures with incentive measures taking into account that soils are very largely privately owned in Europe and not culturally regarded as a common resource

3. OBJECTIVES

In the field of soil contamination several objectives were already highlighted in the Communication, namely:

- to draw a more complete picture of the extent of contamination in the EU enlarged, current situation and trends observed where data is available
- to fully exploit previous work done on the matter by Member States and expert networks such as CARACAS and CLARINET
- to identify best practices in the management of contaminated sites, in relation with identified threats to environment and human health
- to identify necessary measures to avoid new contaminated sites
- to identify best techniques for contaminated sites remediation

4. COMMON TASKS OF THE WORKING GROUP

All Working Groups will have to address general and cross-cutting issues which have a significant impact on their domain. These common tasks are listed in the **Document-1 Framework Mandate** and are recalled hereafter:

- The Working Groups ought to address and provide elements on the following:
  - The basic principles and the extended impact assessment which has to be achieved for the Soil Thematic Strategy.
  - Cross-cutting issues such as climate change, reporting, the state of the soil, the basic typology, the role of agriculture and forestry, awareness, etc.
  - The eight soil threats which are linked to specific groups.

- In order to ensure a high degree of coherence among all reports produced by the Working Groups they shall follow a structure based on the DPSIR model.

[1] Risk Assessment for Contaminated Sites in Europe (CARACAS Volume 1)

[2] Opinions of the Cor, EESC, EP, Council Conclusions, Stakeholders positions

Given the common nature of the task described hereunder, a strong co-ordination between Working Group is paramount. This will be ensured by closely following the guidelines set up in **Document-2 Co-ordination, working methods and common planning** which specifies requirements regarding:

- Co-ordination between advisory forum and working groups
- General information related to participation in WG
- Exchange of information through channels such as the Soil internet site and the CIRCA system

5. SPECIFIC TASKS OF THE WORKING GROUP

5.1. Nature and extent of soil contamination and its consequences for Sustainable Development- social welfare, economy, human health and environment

1- In order to build up on a shared understanding of the contamination problem, the Working Group will develop criteria for a common definition of contaminated soils and sites. These criteria should take into account the use of indicators, the intrinsic chemical properties and good quality and ecological status of the soil, the multifunctionality of soil. In so doing, the Working Group will analyse the various policies already in force in the EU.

2- The Working Group will assess the consequences of soil contamination hindering the achievement of sustainable development and a sustainable use of soil. The impacts on economy, employment, social welfare, environment and human health will be addressed.

5.2. Pressures and drivers causing soil contamination

The Working Group will identify the major sectors and releases causing soil contamination.

5.3. Prevention and remediation of soil contamination

The prevention of further contamination is crucial in order to halt the degradation of soil in the EU. Measures have to be taken at source in order to avoid releases of pollutants to the soil.

1- The Working Group will focus on measures to prevent further contamination particularly by identifying eventual new developments or adjustments of existing environmental legislation to reduce and prevent soil contamination.

<u>For the diffuse contamination, the analysis will focused in particular, but *not solely*, on</u>

- sustainable use of pesticides
- CAP reform and agri-environmental measures
- rational use of fertilisers customised to the crops needs (problems of eutrophication and salinization)
- atmospheric deposition and the legislation on air quality, addressing different sources of diffuse pollution such as transport, industry, households, etc.
- recovery and disposal of waste (e.g. use of compost and sludges). Carrying this task, the Working Group will work closely with the Working Group on Organic matter
- sustainable production and consumption which will reduce the use of dangerous substances in goods which can be subsequently released to the soil

2- The Working Group will assess the problem of "proximity contamination" (occurring at a certain radius of a local source) which can be considered as a hybrid type of contamination between diffuse and local. In particular the eventual need to have a customised approach to tackle this type of pollution ought to be explored.

<u>For local pollution, the analysis will focus in particular, but *not solely*, on</u>

- the IPPC Directive[3]
- the EIA[4] Directive
- the Landfill Directive[5] and other waste legislation
- the Groundwater Directive[6]

3- The Working Group will identify specifically other areas in Community policy, where the integration of soil protection aspects will have a major impact on the prevention of soil contamination.

<u>As far as remediation of historical contamination is concerned, the Working Group will</u>

4- Provide recommendations as soon as possible for the indicators and parameters to monitor soil contamination in the Directive on soil monitoring (both the scenarios of diffuse and local contamination will be taken into account)

5- Explore the aspects related to liability (national regimes and the recent proposal for a future Directive of Council and the European Parliament on environmental damage and liability) and the polluter pays principle

6- Identify the difficulties to set up an inventory of contaminated sites and assess common methodologies already in practice

7- Establish uniform criteria/principles for risk assessment and management of contaminated sites. In particular :

- Develop common risk assessment methodologies, taking into account extensive existing research on the issue, which would use a wide number of receptors (human health, transfer to surface and groundwater but also *inter alia* ecosystems, impacts on biodiversity, etc). Elements such as long term exposure and availability of pollutants ought also to be taken into account.

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[3] OJ L 257, 10.10.1996, p. 26
[4] OJ L 73, 14.03.1997, p. 5
[5] OJ L 182, 16.7.1999, P. 1
[6] OJ L20, 26.01.1980, p.43

- Develop the principles to establish common risk-acceptability criteria for specific land uses
- Develop the principles to establish a list of best available techniques for soil remediation and identify methods for containing the contamination on sites where remediation is not the most environmentally preferable option (e;g. likely damage to specific biodiversity, etc)

8- The Working Group will assess existing and develop new mechanisms to fund the remediation of "orphan" contaminated sites

9- The Working Group will develop the principles to set priorities to build up a national strategy for remedial actions setting up a hierarchy of sites to be decontaminated over time based on:

- ✓ actual and potential risks
- ✓ land uses and possible changes in land uses
- ✓ and taking into account social and economical aspects

5.4. Measures to address soil contamination

1- In assessing measures to be taken, the Working Group will explore the possibilities to encourage the participation of landowners in the spirit of the "working with the market" approach and ensure the prevention of further contamination. The Working Group will also assess relevant aspects of the right of ownership of the land.

2- The Working Group will assess the suitability of establishing a "*Report or Statement on the land status*" to be drawn by the landowner upon any transaction of land property. The possibility of establishing minimum criteria for the content of such report ought to be explored.

5.5. Research needs

Data gaps and research needs related to the above tasks are identified within the working group contamination and next transferred to the working group on research for further evaluation and integration in the research deliverables.

5.6. Level of intervention for the different measures - local, national, regional, EU

The Working Group will assess which is the most appropriate level of intervention for the different measures identified as being needed or desirable. Indeed the application of subsidiarity to soil contamination policy and the possible impacts of regional local or national measures on the internal market will have to be thoroughly assessed. In doing so, the Working Group will take into account the wide variability of soils and land use and the different regional characteristics.

5.7. Options for action and recommendations

On the basis of the outcome of the previous tasks, the Working Group will establish some options and recommendations for the Communication and further actions. Each recommendation or option presented will be accompanied by a justification of the choices, the estimated impacts and costs involved, the time lines and the interlinkages with other measures or policies.

6. SPECIFIC PLANNING

Detailed planning is to be established by the chairs and co-chair, in consultation with the Commission services.

7. CHAIRS/CO-CHAIRS

- Sigbert Huber (joint chair, Austria)
- Joop Vegter (joint chair, The Netherlands)
- Anna Rita Gentile (co-chair, EEA)

8. MEMBERS

(Separate document: please refer to the list of members)

Annex 2 : Erosion mandate

1. INTRODUCTION

Erosion is a physical phenomenon resulting from the removal of soil particles by water or wind, transporting them elsewhere. A main consequence is that ecological, technical, industrial and socio-economic functions of soil become threatened. These functions are:

- Production of biomass, basis for human and animal life.
- Filtering, buffering and transformation capacity
- Biological habitat and gene reserve.
- Spatial base for industrial premises, housing, transport…
- Source of raw materials, energy and water
- Cultural heritage, forming an essential part of the landscape in which we live

Erosion is triggered by a combination of factors such as steep slopes, climate (e.g. long dry periods followed by heavy rainfall), inappropriate land use, land cover patterns (e.g. sparse vegetation) and ecological disasters (e.g. forests fires). Moreover, some intrinsic features of a soil can make it more prone to erosion (e.g. a thin layer of topsoil, low organic matter content).

There are huge differences amongst the European soil types depending on their rock parent material origin and climatic influences (Atlantic, Continental, Mediterranean, Nordic). These differences influence the risks for erosion.

Studies of the economic impact of erosion are scarce. Estimates suggest high indirect costs due to loss in agricultural production potential, sedimentation of water reservoirs, damages due to floods, and damages to roads, houses, infrastructures, etc.

2. PROBLEMS IDENTIFIED

The Communication identified the following issues pertaining to the erosion of soils:

- Human activities can dramatically increase erosion rates.
- Loss of soil functions and irreversibility of severe soil erosion
- Combination of factors such as climate, land use, land cover and intrinsic features like texture or organic matter content, that trigger soil erosion.
- Modelling on erosion risk in Europe is still highly uncertain, because it has not been validated sufficiently in field situations.
- Lack of comprehensive studies of the economic impact of erosion. Available assessments suggest that this is a major challenge.

Other institutions and stakeholders, which have expressed an opinion[7], highlighted major issues encompassing the above-mentioned ones and which are developed under point 4.3 and 4.4 :

- Identification of existing measures and legislation in MS which could be applied at EU level.
- Community policies and measures which can be useful to protect soil against erosion, and those leading to a local increase in soil erosion risk.
- Regionalisation of actions to prevent or remediate soil erosion.
- Concrete measures in agriculture to fight against soil erosion, and also in forestry, sites not vegetated and urban areas.
- Development of programmes in education and training.
- Identification and characterisation of different kind of erosion processes, for instance wind erosion, with the subsequent problems provoked by dust, amongst others, surface and groundwater erosion, and anthro-erosion.

3. OBJECTIVES

Several objectives were already highlighted in the Communication, namely:

- To protect soils against erosion, especially as regards the viability of agricultural land and performance of soil functions.
- To harmonise information (data networks, soil surveys) in Europe.
- To develop an EU soil protection policy on erosion, on the basis of prevention, precaution, and sustainable approach.
- To pursue the integration of soil protection concerns related to erosion in major EU policies.
- To identify the local/regional elements to be integrated into soil protection policies, as a consequence of the diversity of major soil types.

4. COMMON TASKS OF THE WORKING GROUP

All Working Groups will have to address general and cross-cutting issues which have a significant impact on their domain. These common tasks are listed in the **Document-1 Framework Mandate** and are recalled hereafter:

- The Working Groups ought to address and provide elements on the following:
  - The basic principles and the extended impact assessment which has to be achieved for the Soil Thematic Strategy.
  - Cross-cutting issues such as climate change, reporting, the state of the soil, the basic typology, the role of agriculture and forestry, awareness, etc.
  - The eight soil threats which are linked to specific groups.
- In order to ensure a high degree of coherence among all reports produced by the Working Groups they shall follow a structure based on the DPSIR model.

[7] Opinions of the Cor, EESC, EP, Council Conclusions, Stakeholders positions

Given the common nature of the task described hereunder, a strong co-ordination between Working Group is paramount. This will be ensured by closely following the guidelines set up in **Document-2 Co-ordination, working methods and common planning** which specifies requirements regarding:

- Co-ordination between advisory forum and working groups
- General information related to participation in WG
- Exchange of information through channels such as the Soil internet site and the CIRCA system

5. SPECIFIC TASKS OF THE WORKING GROUP

5.1. Nature and extent of soil erosion and its consequences for Sustainable Development

Sustainable use and protection of soil can be defined as the spatial and temporal harmonization of all main uses of soil, minimising irreversible ones.

Some criteria for sustainable soil management are:

- Conserving multi-functionality
- Conserving the biological diversity of soils.

In order to build up on a shared understanding of the erosion problem, the Working Group will develop criteria for a harmonised approach, especially as regards the evaluation of the present situation of soil erosion, taking into account the development and use of indicators, in order to predict, assess or measure key impacts on soil.

The Working Group will also assess the impact of soil erosion on sustainable development and sustainable use of soil, and more specifically on economy, employment, social welfare and environment.

5.2. Pressures and drivers causing soil erosion

One of the main tasks of the Working Group is to identify, describe and propose an analysis of relevant factors and human activities causing soil erosion.

5.3. Prevention and remediation of soil erosion

In order to prevent/remediate the problem of soil erosion, the Working Group will fulfil the following set of tasks:

5.3.1. Status of European soils

A better appraisal of the present situation with respect to soil erosion is necessary. For this purpose existing data, maps, information systems and models should be used.

Soil functions, soil quality (e.g. production capacity or highest water quality) and quality targets, also related to soil use should be defined, Criteria and indicators need to be developed to assess soil sustainable use, and soil protection measures of specific relevance to erosion.

5.3.2. Identification of existing measures/legislation in MS

Attention should be paid to the complexity and diversity of soil protection and also to measures already taken by Member States.

Full consideration should be given to regional and local situations.

A better and comprehensive view and understanding is needed of the actions currently being undertaken in MS. For example there are codes of good agriculture practices for air, water and soil, advice for control of erosion, etc.

5.3.3. Community policies/measures which can be useful to protect soil against erosion:

Existing Community policies and measures should be considered for the implementation of soil erosion measures.

Generally speaking, land and soil are a private property in the EU and not considered as a common resource as rivers, lakes and seas. Subsequently, voluntary or regulatory measures to protect soils are more difficult to apply. Therefore, the Soil Thematic Strategy should be able to address and recognise the rights of use of land owners as well as the protection of a common resource.

The concept of single market may also require a common approach to soil policy, because soil protection at relevant levels may affect competitiveness.

Integration in the following instruments and legislation should include at least:

- Into the CAP and rural development (proposals to reform CAP through cross compliance measures and promotion of agri-environmental measures). Special attention should be paid to abandoned land.
- Into the Structural and Cohesion funds
- The Water Framework Directive will require measures to be adopted within river basins or sub-basins to combat diffuse pollution, which may be indirectly provoked by erosion (nutrients and contaminants linked to eroded soil). Many of these measures can be used to protect soil.

5.3.4. Regionalisation in actions to prevent/remediate soil erosion:

Farmers have to work the soil differently depending on the local conditions. Certain methods could be useful in one region but harmful in others. For instance, deep mechanised tillage may be suitable in heavy soil but unfavourable on fragile Mediterranean soils, where direct sowing makes it possible to maintain a high level of organic matter in soils in areas with fragile structure.

Technical and scientific information exchange between MS is important. Certain MS could be in a position to provide some data and share information with other countries having similar lithographic and climatic systems.

Land use types, climate, soil type, altitude etc., should be taken into account for formulation of actions.

5.4. Measures to address soil erosion

In order to address the problem of soil erosion, the Working Group will fulfil the following set of tasks:

5.4.1. Characterisation of actions to fight against desertification:

Inadequate farming practices and excessive tree-felling may provoke or enhance desertification in the EU. These facts may be a starting point to address actions.

Forest fires are a main cause of desertification in natural Mediterranean areas, due to long term loss of natural vegetation. In order to prevent fires, additional co-ordinated action should be promoted.

The protection of natural forests, afforestation with domestic species and good forestry measures, should be considered as preventive actions.

There are also semi-arid lands and desertification-type problems in other EU areas (for instance in the East Anglia region, UK), where groundwater exploitation and water abstraction from river contribute to arid conditions.

Decline in organic matter and losses of soil structure significantly contribute to erosion. In the Communication a limit value of 1.7 % soil organic matter content is considered as an indicator of a pre-desertification stage.

A clear notion of the water cycle is necessary. In this context it is required to look at soil suitability for crops under specific climatic conditions. This is particularly relevant in Mediterranean areas, in comparison with other European areas, due to limited water resources in those areas. In arid and semi-arid regions rainfall and water is a limit of what can be produced. A complexity of factors together with water storage and distribution may lead to increased aridity.

5.4.2. Concrete measures in agriculture and forestry to fight against soil erosion

Development of rational land use policies, including targets and actions, promotion of good farming practices and anti-erosion measures could be included in existing Community financing instruments and at national/regional level.

Those actions could include:

- Identification of vulnerable zones.
- Study of irrigation systems which may cause erosion;
- Encouragement of crop rotation, including crops producing high amounts of biomass residues, and leaving the crop residues, if possible, on the soil; cultivation of legumes and protein crops (crops significantly contributing to increase organic matter in soil), specific measures for set-aside land; measures to maintain and increase permanent pasture should be considered. Additional benefits of those measures for example for biodiversity should be highlighted.
- Use of grass strips on erodible arable slopes; if necessary, only tillage parallel to contour lines.
- Cultivation in small plots, planting of hedgerows, copses, no tillage or reduced tillage; restrictions in the use of heavy mechanised equipment.
- Small scale anti-erosive measures, like small dams, erosion ponds and so on.
- Guidelines for rehabilitation of erosion affected land.
- Wide range of policy tools need to be considered, including for example the use of incentives or the erosion tax.
- Measures to avoid soil erosion caused by overgrazing and wrong types of farm animals.
- Concrete measures in forestry to fight against soil erosion should include:
    - ❖ Identification of vulnerable sites
    - ❖ Afforestation and reforestation
    - ❖ Designation and promotion of protective forests and encouragement of their adapted management

5.4.3. Development of programmes in education and training:

The integration of education and dissemination of information in the Soil Thematic Strategy should be promoted to increase understanding, awareness and knowledge of the impact of different activities on soil erosion. These programmes should particularly encourage land protection.

There is a clear need for training and transfer of technology to farmers and public in general, in order to raise awareness on the main causes for erosion. Farmers need to be fully aware of the nature of the problem and of their responsibilities. It must be ensured that they are engaged in seeking the solutions. Dissemination of new techniques to farmers is also necessary so that they can be put into practice, taking into account their local situations and their socio-economic context.

5.4.4. Identification and characterisation of other kind of erosion processes:

Erosion for example due to the harvesting of roots and tubers, such as potatoes, sugar beet, in bad weather conditions, and due to land levelling operations may contribute significantly to erosion in a number of regions and Member States.

Specific actions may be required to address wind erosion, for instance wind-screen strips and programmes promoting hedges.

Erosion by rivers and lakes can cause loss of land which may lead to landslides; in coastal areas severe erosion can occur. Groundwater flows can provoke internal erosion. All these questions will become increasingly important in the next decades due to the global climate change.

5.4.5. Development of studies of the economic impact of erosion:

Soil protection is a basic condition for sustainable development. Greater attention should be paid to the social, health and economic aspect next to the environmental aspects of sustainable development. Specific studies on this issue may be required.

5.4.6. Monitoring recommendations

The working group should reflect and establish monitoring indicators and criteria related to the actions and recommendations for erosion. Both action-driven and

multi-purpose monitoring recommendations on erosion will contribute to the tasks of the monitoring working groups and the proposal for a Directive on soil monitoring. Those recommendations are transferred to the working group on monitoring for further evaluation and integration into the monitoring deliverables.

Opportunities to use new, harmonised and innovative methods, techniques and technologies should be addressed.

5.5. Research needs

Data gaps and research needs related to the above tasks are identified within the working group erosion and next transferred to the working group on research for further evaluation and integration in the research deliverables.

5.6. Level of intervention for the different measures- local, national, regional, EU

The Working Group will assess which is the most appropriate level of intervention for the different measures identified as being needed or desirable. In doing so, the Working Group will take into account the wide variability of soils and land use and the different regional characteristics.

5.7. Options for action and recommendations

On the basis of the outcome of the previous tasks, the Working Group will establish options and recommendations for actions in support to the new Communication. Each recommendation or option presented will be accompanied by a justification of the choices, the estimated impacts and costs involved and the time lines.

6. SPECIFIC PLANNING

Detailed planning is to be established by the chairs and co-chair, in consultation with the Commission services.

7. CHAIRS/CO-CHAIRS

- Victor Castillo Sánchez (joint chair, Spain)
- Liesbeth Vandekerckhove (joint chair, Belgium)
- Rob Jarman (co-chair, EEB)

8. MEMBERS

(Separate document: please refer to the list of members)

Annex 3 : Organic matter mandate

1. INTRODUCTION

Organic carbon in the soil fulfils essential functions with respect to soil structure and stability, soil fertility and water retention capacity. Soil organic carbon contributes to long term maintenance of proper soil functioning and fertility and is also a useful archive to learn from the past . Therefore organic matter plays a central role in maintaining soil functions and in increasing resistance against erosion. Through its binding and buffering capacity soil organic matter contributes to control the spreading of pollution from soil to water

It is known that certain agricultural practices, in particular on arable land, are leading to decrease of organic carbon in the soil and there is evidence that under current conditions European soils under agricultural land are sources of organic carbon rather than sinks.

Organic carbon sequestration in European soils is a potential tool for reducing greenhouse gas emissions both by reducing the emissions from agricultural soils and by sequestration of organic carbon in the soil. Estimates indicate that organic carbon sequestration in agricultural soils can account for about 20% of the total reduction required in the EU during the first commitment period (8% reduction required between 2008 and 2012 from a 1990 base). Climate change will also have implications on the cycle of organic matter.

2. PROBLEMS IDENTIFIED

The following issues have been identified pertaining to organic matter in soils:

- Decrease of organic matter content in European soils leading to soil degradation and deterioration
- Loss of soil functions and soil fertility
- Loss of soil biodiversity
- Links between organic matter depletion and increased erosion and desertification.
- Contribution of agricultural land to greenhouse gas emissions
- Risks of pollution through the spreading of low quality compost, ,sludge or other waste derived organic additions on land
- Loss of buffering capacity of soils leading to increased risks for floods
- Loss of soil structure and stability
- Effects of land use changes on organic matter content
- Lack of awareness of the risks related to organic matter depletion
- Importance of economically viable solutions to combat loss of organic matter
- Lack of knowledge and awareness on downstream effects
- Absence of EU harmonised methods to measure organic carbon in soils
- Absence of “good status” values for a variety of european soils
- High variability of the problem due to variability of soil types, land uses and climate conditions
- Importance of financial incentives to protect soils through increase of organic matter
- Necessity of preventive actions to avoid further decrease of organic matter content.
- Need to adjust land use to soil capacity and suitability
- Slow build-up processes of organic matter which is also depending on environmental conditions
- Lack of socio-economic data and impact assessments

3. OBJECTIVES

The following objectives have been highlighted:

- Develop harmonised methods to measure and monitor organic carbon in soil
- Assess the status of European soils for the enlarged EU
- Highlight the multiple roles of organic matter in the soil and define the consequences of a lack of organic matter
- Obtain a better insight in processes leading to depletion
- Formulate good management practices (including organic farming) related to organic matter in the context of its multiple functions while taking into account possible interactions with other compartments and regional circumstances.
- Formulate actions for areas where soil degradation is a risk.
- Contribute to monitoring in the context of action
- Contribute to research gaps and needs in the field of organic matter

4. COMMON TASKS OF THE WORKING GROUP

All Working Groups will have to address general and cross-cutting issues which have a significant impact on their domain. These common tasks are listed in the **Document-1 Framework Mandate** and are recalled hereafter:

- The Working Groups ought to address and provide elements on the following:
  - The basic principles and the extended impact assessment which has to be achieved for the Soil Thematic Strategy.
  - Cross-cutting issues such as climate change, reporting, the state of the soil, the basic typology, the role of agriculture and forestry, awareness, etc.
  - The eight soil threats which are linked to specific groups.
- In order to ensure a high degree of coherence among all reports produced by the Working Groups they shall follow a structure based on the DPSIR model.

Given the common nature of the task described hereunder, a strong co-ordination between Working Group is paramount. This will be ensured by closely following the guidelines set up in **Document-2 Co-ordination, working methods and common planning** which specifies requirements regarding:

- Co-ordination between advisory forum and working groups
- General information related to participation in WG
- Exchange of information through channels such as the Soil internet site and the CIRCA system

5. SPECIFIC TASKS OF THE WORKING GROUP

5.1. Nature and extent of decrease in organic matter and its consequences for sustainable development

1- The working groups should establish a European wide assessment of the state of organic matter in soils. The future developments of soil status should be described in case action is not taken. Particular attention should be attributed on long-term developments and in particular, but not only, with respect to climate change. This assessment should be based on available data and knowledge. Data gaps and additional needs should be identified.

2- The value of organic matter ("black gold"), both in term of quantity and quality, has to be highlighted by underlining the role organic matter has in fulfilling a complexity of soil functions. The multiple consequences of lack of organic matter have to be made explicit. This principal analysis should include the links to other compartments of environment and soil use (water, air, climate change, land use, agriculture, desertification, floods, biodiversity, etc.). The role of organic matter in the soil-water-air system has to be addressed.

3- Both the European wide assessment and the analysis of the values of organic matter should lead to a complete picture on the status and importance of soil organic matter in Europe. This assessment should allow to identify how much area is affected in each member state and candidate country and to which degree.

4- Pressures and drivers causing decrease in organic matter leading to soil degradation.

The working group should present an integrated analysis of pressures and driving forces that have been leading to decrease of organic matter during the last decades. This analysis should included environmental as well as social and economic forces that have contributed to the present situation.

This analysis should include changes in land use, soil management, forest management and agricultural practices like manure and livestock management.

5.2. Prevention and remediation of soil degradation due to changes in organic matter content

1- The Working Group will identify possible actions and measures to maintain and increase organic carbon in the soil. Instruments will include integration into existing policies as well as development of new actions in the framework of the soil thematic strategy.

The analysis will focus in particular, but not solely, on

- Good practices to maintain the level of organic matter in the soil
- Most promising measures to increase organic carbon in the soil.

An assessment of at least the following measures should be included:

- Promote organic input on arable land: crop residues, cover crops, farmland manure, compost, sewage sludge.
- Zero tillage or reduced tillage
- Permanent revegetation
- Winter cover and green manuring
- Specific measures for soils with a high organic carbon content such as peat lands
- Longer rotations
- Moderate intensification

- Specific actions and recommendations for areas where the risk for soil degradation is high.

<u>The following issues should be covered during formulation of actions:</u>

- Downstream effects and impacts of the actions include at least prevention of pollution spreading, erosion, desertification and flood. These effects should be made explicit.
- Organic carbon in the soil should be looked at:
  - as a means for climate mitigation (The work carried out by ECCP to assess the potential carbon sequestration in agricultural soil has to be taken into account)
  - as a central element in soil protection and sustainable soil functioning and use.
- Strengths and weaknesses and possible barriers in their implementation for each action should be identified.
- Possibilities to use EU financial instruments must be explored taken into account the time scale needed to increase organic carbon in the soil. This includes structural funds as well as agricultural and rural development programmes.
- Possibilities to develop new instruments like fiscal incentives should be explored.
- Aspects related to liability (including the recent proposal for a Directive of Council and the European Parliament on environmental damage and liability) and the polluter pays principle should be addressed.

2- The working groups should identify criteria and indicators related to the actions and recommendations (action-driven monitoring). As a contribution to multi-purpose monitoring the working groups should address criteria and indicators for the assessment of the development of organic matter in European soils. Particular attention should be given to the suitability of bio-indicators and soil biodiversity.

This task includes:

- Development of "good status" values as well as "threshold values" beyond which action is required taken into account the wide variability of soil types, ecosystems and functions.
- Identification of major difficulties for assessment and monitoring of organic carbon in the soil. Possibilities for inter-calibration of existing methods should be evaluated.

Both action-driven and multipurpose monitoring recommendations on organic matter contribute to the tasks of the monitoring working group and the proposal for a Directive on soil monitoring. Those recommendations are transferred to the working group on monitoring for further evaluation and integration into the monitoring deliverables.

5.3. Research needs

Data gaps and research needs related to the above tasks are identified within the working group organic matter and next transferred to the working group on research for further evaluation and integration in the research deliverables.

Suggestions for future research needs may include e.g.:

- establish the potential of management /land-use changes for arable land, peatland and grassland to sequester carbon and to quantify the impacts of other environmental effects including other greenhouse gases such as nitrous oxide and methane;
- establish the potential for carbon to be sequestered according to local conditions i.e. soil type, climate, nutrients situation.

5.4. Level of intervention for the different measures - local, national, regional, EU

The Working Group will assess which is the most appropriate level of intervention for the different measures identified as being needed or desirable. In doing so, the Working Group will take into account the wide variability of soils and land use and the different regional characteristics.

5.5. Options for action and recommendations

On the basis of the outcome of the previous tasks, the Working Group will establish options, recommendations and actions in support to the future Communication. Each recommendation and action presented will be accompanied by a justification of the choices, the estimated impacts and costs involved, the time lines and the linkages with other measures or policies.

6. SPECIFIC PLANNING

Detailed planning is to be established by the chairs and co-chair, in consultation with the Commission services.

7. CHAIRS/CO-CHAIRS

- Michel Robert (chair, France)
- Stephen Nortcliff (joint co-chair, IUSS)
- Elise Bourmeau (joint co-chair, FEAD)

8. MEMBERS

(Separate document: please refer to the list of members)

Annex 4: Monitoring mandate

1. INTRODUCTION

The soil communication foresees the development of a soil monitoring directive as a major building brick of the soil thematic strategy. This monitoring directive, when implemented, should deliver data that should allow to review and adjust the EU soil policy at regular intervals, in order to increase its effectiveness.

The monitoring directive is the first legislative initiative at EU level that is specifically designed for soil and therefore also fulfils the role of a "pilot project". Much of the eventual success of the soil thematic strategy will therefore also depend on the effectiveness of the monitoring directive. This Directive will have to fit in the overall exercise of streamlining environmental reporting so as to make it useful for a variety of information users.

The working group's major task is to support the development of efficient and cost-effective soil monitoring tools, options and recommendations in the enlarged EU.

2. PROBLEMS IDENTIFIED

The Communication identified the following problems pertaining to the soil monitoring and surveys:

- most national soil surveys were established several decades ago and mainly in relation to agricultural use
- there is a problem of comparability on soil data due to the different methodologies and definitions used in Member States
- existing EU wide soil information system such as the European Soil Information System, are based on data collected through different methodologies and do not include trends or indications of changes.
- several Member States have developed there own monitoring systems which address different parameters and are based on different periodicities and grids
- the European-wide forest monitoring system in place (Regulation EEC N°3582/86 on the Protection of Forest), although it shares some common grounds, has not been designed to address all the necessary aspects of soil protection
- it should be possible to integrate the soil monitoring system into the comprehensive multi-layered monitoring and reporting systems presently under development at EU level (INSPIRE, the horizontal environmental reporting requirements and GMES)

Other institutions and stakeholders, which have expressed an opinion[8], highlighted additional major issues:

- the soil monitoring system would have to be based as far as possible on already existing systems
- the possibility of launching the soil monitoring through initial pilot projects ought to be explored
- the Working Group should fully exploit previous work carried out. This includes work done by JRC, EEA and expert networks as well as work done within the context of Regulation EEC N° 3582/86 on the protection of forest.
- monitoring as regards local contamination has been so far mainly targeted to support the management of contaminated sites whereas information on wider environmental impacts of contamination is almost not available.

3. OBJECTIVES

Main tasks of the working group is to develop options and recommendations in support to the development of the proposal for a soil monitoring directive.

In the field of soil monitoring, two types of monitoring can be distinguished corresponding to two main objectives:

1- The "multi-purpose monitoring"

This monitoring approach serves as a tool to complete data gaps and update knowledge and information on the environment of relevance to soil policy. This monitoring serves in the longer term to increase the "knowledge-base" for the policy. Its aim is to:

- achieve relevant, accurate, reliable and comparable data for all MS on the status of soil, its quality and ecological status
- establish harmonised sampling procedures and soil analytical measures, data transfer and methodologies

2- The "action-driven monitoring"

The future Directive on soil monitoring must also provide the tools and the framework to assess the effectiveness of the measures or actions taken to prevent/combat the soil degradation and threats identified in the Communication[9]. It must also contribute to the evaluation and review of soil protection policy.

4. COMMON TASKS OF THE WORKING GROUP

All Working Groups will have to address general and cross-cutting issues which have a significant impact on their domain. These common tasks are listed in the **Document-1 Framework Mandate** and are recalled hereafter:

- The Working Groups ought to address and provide elements on the following:
  - The basic principles and the extended impact assessment which has to be achieved for the Soil Thematic Strategy.
  - Cross-cutting issues such as climate change, reporting, the state of the soil, the basic typology, the role of agriculture and forestry, awareness, etc.
  - The eight soil threats which are linked to specific groups.

[8] Opinions of the Cor, EESC, EP, Council Conclusions, Stakeholders positions

[9] 8 Threats: erosion, contamination, salinisation, compaction, contamination, organic matter, loss of biodiversity, floods and landslides

- In order to ensure a high degree of coherence among all reports produced by the Working Groups they shall follow a structure based on the DPSIR model.

Given the common nature of the task described hereunder, a strong co-ordination between Working Group is paramount. This will be ensured by closely following the guidelines set up in **Document-2 Co-ordination, working methods and common planning** which specifies requirements regarding:

- Co-ordination between advisory forum and working groups
- General information related to participation in WG
- Exchange of information through channels such as the Soil internet site and the CIRCA system

5. SPECIFIC TASKS OF THE WORKING GROUP

5.1. Soil diversity in EU

As pointed out by many stakeholders, in order to be successful, any soil monitoring scheme in the EU will have to take fully into account the variability of soil types, climatic conditions, etc. For that purpose the Working Group will develop mechanism to reflect and address this variability of soils in the EU, in particular looking at the possibility of using soil typologies and characterisation as a basis for the development of customised monitoring. The issue of using a multiple soil classification systems or a harmonised soil taxonomy should be explored (in doing so the work done previously in the context of the World Reference Base for Soil Resources ought to be considered)

5.2. Nature of the monitoring

1- In order to assess the growing damage occurring in the EU soil in a more strategic manner, the Working Group will identify indicators to monitor the impact of the soil degradation and threats identified on the sustainable use of soil and Sustainable Development, namely on economy, employment, social welfare, environment and human health.

2- In a more specific manner, for each of the eight threats the Working Group will identify the parameters and indicators to be monitored at the appropriate level. Subsequently, the possibility of having a customised monitoring strategy for different regions and different types of soils with different sets of parameters to be looked upon could be explored. Over time the monitoring of these parameters must allow to establish trends in order to, *inter alia*,

- identify where specific protective actions are needed
- evaluate the efficiency of measures already in place

5.3. Set up of the monitoring scheme

1- To fully profit from existing expertise and structures, the Working Group will analyse and compare existing monitoring, survey, GIS, inventories and mapping systems in Member States, highlighting the most efficient features. Any new soil monitoring scheme would have to be coherent with other Directives such as the Habitats Directive and the Water Framework Directive.

2- Furthermore the Working Group will make recommendations on the network of observations and monitoring procedures to be followed (periodicity, authorities involved, quality checks, etc.). The use and application of remote sensing technologies (both space and air-borne) ought to be explored.

5.4. Harmonisation of data

Identify and assess the gaps in harmonisation (including standardisation) which would need to be filled to achieve harmonised definitions, sampling and analytical procedures. This assessment ought to cover the aspects of availability of laboratory capacities in the Member States and Accession Countries. It should also take into account ongoing harmonisation exercises such as the "HORIZONTAL project" led by he European Commission and Member States.

5.5. Access to information

Taking into account the fact that soil is largely privately owned in the EU, the Working Group will analyse the difficulties of setting up a soil monitoring system linked to the private ownership of the land. It will in particular analyse the relationship between public access to information, rights on environmental and health protection and private ownership of the land.

5.6. Costs involved

The Working Group will very thoroughly assess the costs involved in the different monitoring scenarios and for different types of monitoring.

5.7. Research needs

Data gaps and research needs related to the above tasks are identified within the working group monitoring and next transferred to the working group on research for further evaluation and integration in the research deliverables.

5.8. Co-ordination with other working groups

Working groups on erosion, contamination, organic matter and research are requested to contribute to the monitoring process and developments within the context of their specific mandates. "Action oriented" working groups (erosion, contamination and organic matter) contribute in particular to action-driven monitoring.

Recommendations from working groups serve as input to the monitoring working group where they are further evaluated and integrated. Strong co-ordination between working groups is therefore required.

5.9. Level of intervention for the different monitoring measures - local, national, regional, EU

The Working Group will assess which is the most appropriate level of intervention for the different monitoring schemes presented. In doing so, the Working Group will take into account the wide variability of soils and land use and the different regional characteristics.

5.10. Options for action and recommendations

On the basis of the outcome of the previous tasks and the input provided by the other Working Groups, the Working Group will establish options and recommendations in support of the proposal for a Directive on Soil Monitoring. Each recommendation or option presented will be accompanied by a justification of the choices, the estimated impacts and costs involved, the time lines and the linkages with other measures or policies.

6. SPECIFIC PLANNING

Detailed planning is to be established by the chairs and co-chair, in consultation with the Commission services.

7. CHAIRS/CO-CHAIRS

- Joachim Woiwode (joint chair, Germany)
- Luca Montanarella (joint chair, European Commission, JRC)
- Peter Loveland (co-chair, UK)

8. MEMBERS (SEPARATE DOCUMENT: PLEASE REFER TO THE LIST OF MEMBERS)

Annex 5: Research mandate

1. INTRODUCTION

Soils have been subject to research and studies since many decades and much information is generally available. Despite of this, lack of information is apparent in a number of fields. In other cases existing information is not brought to best/maximum use for policy. This leads, in a number of cases not only to duplication of effort, but also to uncertainties about usefulness of the scientific results for policy purposes.

Soil is an environmental component characterised by a great diversity. Soils differ widely also in terms of their capacity to support environmental and productive functions. An effective soil protection and land use policy should recognise this diversity and base its actions on it.

The combination of the wealth of soil information available (sometimes scattered, little structured or relevant), and the high variability of soils and soil capacities (not entirely classified, characterised and harmonised) may bring policy makers in front of high degrees of uncertainties and consequently difficult choices in areas where action is nevertheless required in line with the precautionary principle.

The working groups on research is therefore concerned with,

- identifying and structuring existing information in order to make it more easily available
- analysing barriers that prevent full use of scientific results for policy
- formulating recommendations to improve the transfer of information
- identifying addition research needs based on directions to take at short, medium and long term.

2. PROBLEMS IDENTIFIED

- Existing information, although abundantly available for a number of soil issues, is not put to its maximum use for a variety of reasons such as lack of awareness of its existence, lack of relevance to policy, lack of dissemination efforts, etc.
- A forum for exchange of (EU wide) information between researchers and policy makers has been lacking. Transfer of knowledge to those who are using it is not always efficient.
- Regional unbalance in data and availability of results exist.
- Existing information may give good indications for local situations but does not allow extrapolating results due to variability in soils.
- Comparison of results is often not possible for a variety of reasons such as lack of harmonisation across Europe.
- Soil types have been identified in Europe with variable degrees of precision, definition and characterisation. This basic work on EU wide soil typologies, including a description of the status of European soils is presently not completed.
- Numerous studies focus on isolated aspects/components of soil in great detail. While this fundamental research is often required, and may need to be extended, the links to a wider use, including in a policy context, is not always addressed.
- Integrated and basic aspects of soils such as soil as an ecosystem and the soil-water-air system has not sufficiently been addressed.
- Significant uncertainties about the risk for human health, soil biodiversity, soil quality and soil functions continue to exist.
- New and innovative technologies are not sufficiently used in soil management.
- Research has not sufficiently been demand driven.
- Role of soil as a crucial link between many earth surface processes, and as an impressive array of functions and services has not sufficiently been recognised
- Links between soils and environmental problems of global dimension has not sufficiently been emphasised: loss of biodiversity, global change, desertification, deforestation, etc.
- Fundamental reasons explaining why we need to protect soils have not sufficiently been addressed (facts and figures, scope and influence of soil on human activity). This should range from ecology to agronomy, from engineering to floods.
- Lack of partnerships building, capacity building and education in the soil domain is emerging.

3. OBJECTIVES

The objective of the working group on research is to support the short, medium and long term developments of research needs in the soil field. This includes:

- Research issues identified within the three thematic working groups.
- Research issues associated to the five other threats.
- New developments and cross-cutting issues.

This is achieved by:

- Facilitating maximum use of existing information
- Identifying existing gaps and areas where research is required.

4. COMMON TASKS OF THE WORKING GROUP

All Working Groups will have to address general and cross-cutting issues which have a significant impact on their domain. These common tasks are listed in the **Document-1 Framework Mandate** and are recalled hereafter:

- The Working Groups ought to address and provide elements on the following:
  - The basic principles and the extended impact assessment which has to be achieved for the Soil Thematic Strategy.

  - Cross-cutting issues such as climate change, reporting, the state of the soil, the basic typology, the role of agriculture and forestry, awareness, etc.
  - The eight soil threats which are linked to specific groups.

- In order to ensure a high degree of coherence among all reports produced by the Working Groups they shall follow a structure based on the DPSIR model.

Given the common nature of the task described hereunder, a strong co-ordination between Working Group is paramount. This will be ensured by closely following the guidelines set up in **Document-2 Co-ordination, working methods and common planning** which specifies requirements regarding:

- Co-ordination between advisory forum and working groups
- General information related to participation in WG
- Exchange of information through channels such as the Soil internet site and the CIRCA system

5. SPECIFIC TASKS OF THE WORKING GROUP

5.1. Facilitate maximum use of existing information

To facilitate maximum use of existing information, in particular but not only for EU soil policy making, the working groups should:

- Establish an overview (inventory) of existing information listing main areas of research where much information is available. Present an analysis of main driving forces behind the needs for this information both for the past and the present.
- Establish a set of criteria to assess strengths and weaknesses of presently available information, and present them in a classified manner.
- Identify areas where much information exists that has not been thoroughly used. Focus on the main reasons why this information has not been entirely used and present actions that could encourage its use for a range of purposes.
- Present specific recommendations that will allow making this information more easily accessible to the wider public and to the policy makers.
- Establish actions, in particular in the field of awareness rising and dissemination, that will encourage the use of existing information to a wider public and to policy.

5.2. Identify existing gaps and new areas where research is required

Research gaps correspond to gaps in existing information while *new research areas* is concerned with new areas and directions in soil research that have not yet been explored.

Research gaps and new research areas can be *identified* in all five working groups. The research working group receives this input from the other working groups, discusses and evaluates all proposal and makes final recommendations for future research needs. Strong co-ordination is therefore required between the groups.

The research working group establishes a coherent set of criteria to evaluate proposals for new research areas at short, medium and long term. This set of criteria should include amongst others:

- EU wide applicability
- Harmonised methods
- Integrated and holistic approaches
- Ecosystem approach

5.3. Focus on key areas of interest

The research working group contributes to basic definitions and cross-cutting issues (see Framework Mandate).

This includes, among others, the following issues:

- Harmonisation of soil information at EU, including typology and characterisation of soils
- Vulnerability of soils and exposure to damage and soil degradation associated to the typologies; development of a generic conceptual framework for soil risk assessment and management.
- Risk management in the context of an ecosystem approach; functioning and structure of ecosystems and how land use affects them; definition and improvement of management measures to implement an ecosystem approach
- Interface between soil, groundwater and surface waters
- Interface between soil, land, land use and land use planning
- Integrating of social, economic and ecological considerations into decision-making
- Identification of barriers for a successful application in Europe for new technologies and techniques; recommendations to overcome those barriers
- Innovative methods in monitoring and evaluation incorporating the potential of new technologies. Efficient spatial sampling methods to obtain representative data; frequencies and densities taking into account the complexity and variability of soils.
- Development of a network for timely diagnosis and warning based on quality indicators and degradation indicators
- Interaction between detailed process studies (for example on erosion, sedimentation, organic matter) and databases at different area and time scales, and how to make best use of combined information of diverse origin.
- Diffuse soil pollution and atmospheric deposition due to industry, agriculture, energy production, traffic, consumption; faith of pollutants, natural barriers and ecological processes in the soil.

6. SPECIFIC PLANNING

Detailed planning is to be established by the chairs and co-chair, in consultation with the Commission services.

7. CHAIRS/CO-CHAIRS

- Jürgen Büsing (joint chair, European Commission, DG RTD)
- Winfried Blum (joint chair, personal capacity)
- Thierry de l'Escaille (co-chair, ELO)

8. MEMBERS

(Separate document: please refer to the list of members)

Annex 6: List of acronyms of organisation names

APAT	Italian Agency for the Protection of the Environment and for Technical Services
ASSURRE	The Association for the Sustainable Use and Recovery of Resources in Europe
CEAM	Centro de Estudios Ambientales del Mediterraneo
CEN	The European Committee for Standardisation
CESIO (CEFIC)	Comité Européen des Agents de Surface et leurs Intermédiaires Organiques
CODACONS	Coordinamento delle Associazioni di Tutela dell'Ambiente e dei Consumatori ed Utenti
COPA-COGECA	Committee of Agricultural Organisations in the EU - General committee for Agricultural Co-operation in the EU
ECAF	European Conservation Agriculture Federation
ECN/ORBIT	European Compost Network
ECPA	European Crop Protection Association
EEA	European Environment Agency
EEB	European Environmental Bureau
EFMA	European Fertiliser Manufacturers Association
ELO	European Landowners' Organisation
ELSA	European Land and Soil Alliance
EPRO	Environmental Platform for Regional Offices
Eureau	European Union of National Associations of Water suppliers and Waste Water Services
EUROCOAL	European Coal and Lignite Association
EUROFER	European Confederation of Iron and Steel Industries
FEAD	Fédération Européenne des Activités du Déchet et de l'Environnement
GeoEnvNet	Geoenvironmental Engineering Infrastructure Co-operation Network
ICLEI	International Council for Local Environmental Initiatives
IIRB	International Institute for Beet Research
INERIS	Institut National de l'Environnement industriel et des Risques
IRSN	Institute for Radiological Protection and Nuclear Safety
ISR-cer	Instituto para la Sostenibilidad de los Recursos
ISSDS	Istituto Sperimentale per lo Studio e la Difesa del Suolo
ISWA	International Solid Waste Association
IUSS	International Union of Soil Sciences
JRC	Joint Research Center
METROPOLIS	European Commission co-funded project : Metrology in support of precautionary sciences and sustainable development policies
NEEIP	Non-energy extractive industries panel
NICOLE	Network for Industrially Contaminated Land in Europe
OVAM	Openbare Afvalstoffen Maatschappij voor het Vlaamse Gewest
SCAPE	European Commission co-funded project : Soil Conservation And Protection strategies for Europe

MEMBERS OF THE WORKING GROUPS

WORKING GROUP ON EROSION

CHAIRS AND CO-CHAIR

Víctor Castillo Sánchez (Joint Chair, Spain), Liesbeth Vandekerckhove (Joint chair, Belgium)
Rob Jarman (Co-chair, EEB)

Austria	1. Peter Strauss
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France	4. Yves Le Bissonnais
Germany	5. Holger Böken
Netherlands	6. Luuk Dorren
Portugal	7. Ana Zúquete
Spain	8. Juan Sánchez Díaz
Sweden	9. Bengt Rydell
UK	10. Peter Redfern
Greece	11. Sid. P. Theocharopoulos
Hungary	12. Judit Berényi Üveges
EPRO[1]	13. Giosuè Loj
SedNet[2]	14. Philip N. Owens
EuroGeoSurveys	15. Olaf Düwel
European Water Association EWA	16. Konrad Mollenhauer
European Soil Bureau Network	17. Arnold Arnoldussen
ELO[3]	18. Tanya Olmeda-Hodge
ECPA[4]	19. Michael Lane
COPA[5]	20. José Fernando Robles del Salto
FEAD[6]	21. Maelenn Poitrenaud
IIRB[7]	22. Heinz-Josef Koch
Council of European Municipalities and Regions	23. Joern Gettermann
ECAF[8]	24. Armando Martínez Vilela
ESSC[9]	25. José Luis Rubio
Geographic balance	
Soil Science and Conservation Institute (SK)	26. Josef Kobza
Bulgarian Executive Environment Agency	27. Yavor Yordanov
APAT[10]	28. Renzo Barberis
Swiss Federal Research Station for Agroecology and Agriculture	29. Volker Prasuhn
Soil Science and Conservation Institute (SK)	30. Pavel Jambor
Jordforsk- Norwegian Centre for Soil and Environmental Research	31. Lillian Øygarden

Continued….

[1] Environmental Platform for Regional Offices
[2] European Sediment Research Network
[3] European Landowners' Organisation
[4] European Crop Protection Association
[5] Committee of the Agricultural Organisations in the EU
[6] European Federation of Waste Management
[7] International Institute for Beet Research
[8] European Conservation Agriculture Federation
[9] European Society for Soil Conservation
[10] Italian Agency for the Protection of the Environment and for Technical Services

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SCAPE (support to Soil Thematic Strategy)	33. Anton Imeson
Agence de l'Eau Seine Normandie	34. Carole Mathieu
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ISR-cer[11]	36. José María Oteiza Fernández-Llebrez
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European Commission

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EEA	41. Jaume Fons Esteve
DG Environment	42. Benilde Bujarrabal

[11] Instituto para la Sostenibilidad de los Recursos
[12] Istituto Sperimentale per lo Studio e la Difesa del Suolo
[13] Centro de Estudios Ambientales del Mediterraneo

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Continued….

WORKING GROUP ON ORGANIC MATTER and BIODIVERSITY

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JRC	Rainer Baritz
DG ENV	Luca Marmo
DG ENV – Soil Thematic Strategy	Lieve Van Camp

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Eurometaux	18. Hugo Waeterschoot
CEN	19. Tim Evans (TC 223)
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EFMA[2]	21. Christian Pallière
ELO[3]	22. Ronan Girard
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ICLEI[4]	24. Elisabeth Steenberg
ISWA[5]	25. Morten Brøgger
EUROFER[6]	26. Patrick Charbonnier
GeoEnvNet[7]	27. Hywel Thomas
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[1] European Union of National Associations of Water suppliers and Waste Water Services
[2] European Fertiliser Manufacturers Association
[3] European Landowners' Organisation
[4] International Council for Local Environmental Initiatives(ICLEI)
[5] International Solid Waste Association
[6] European Confederation of Iron and Steel Industries
[7] Geoenvironmental Engineering Infrastructure Co-operation Network
[8] Network for Industrially Contaminated Land in Europe
[9] European Crop Protection Association
[10] European Coal and Lignite Association
[11] Institute for Radiological Protection and Nuclear Safety
[12] Non-energy extractive industries panel
[13] European Compost Network

* These Member States or organisations have already been requested to limit the candidacies to a single delegate. The name of the final candidate retained will be provided

WORKING GROUP ON MONITORING

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Sweden	12. Ola Inghe
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Poland	14. Witold Stepniewski
Czech Republic	15. Ladislav Kubík
Hungary	16. Judit Berényi Üveges
EEB	17. Gerassimos Arapis
EuroGeoSurveys	18. Clemens Reimann
CEN	Jens Utermann
Eureau[1]	19. Vera Szymansky
European Soil Bureau Network	20. Eric Van Ranst
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ECAF[3]	22. Michele Pisante
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[1] European Union of National Associations of Water suppliers and Waste Water Services
[2] European Landowners' Organisation
[3] European Conservation Agriculture Federation
[4] Committee of Agricultural Organisations in the European Union
[5] European Confederation of Iron and Steel Industries
[6] Non-energy extractive industries panel
[7] European Land and Soil Alliance
* These Member States or organisations have already been requested to limit the candidacies to a single delegate. The name of the final candidate retained will be provided

WORKING GROUP ON RESEARCH

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Member States and candidate countries	
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Germany	6. Jörg Frauenstein
Netherlands	7. Johan van Veen
Portugal	8. Corina Carranca
Spain	9. Filipe Macias/Marta Camps
Sweden	10. Stig Ledin
UK	11. Peter Costigan
Poland	12. Jerzy Weber
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EUROFER	14. Günter Paul
EuroGeoSurveys	15. Dominique Darmendrail
CEN	16. Jiri Zbiral
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ECAF	20. Friedrich Tebrügge
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International Institute for Beet Research	24. John Pidgeon
Common forum on contaminated land in the EU	25. Bob Harris
Int. Council for local environmental initiatives (ICLEI)	26. Wolfgang Burghardt
GeoEnvNet	27. Hywel Thomas/Andreas Loibner
EURACOAL	28. Jesus Suso
IUSS	29. Emmanuel Frossard
European Federation of Geologists (EFG)	30. Loreto Farrell/Jan Curlik
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Consejo superior de investigaciones cientificas, Spain	44. Damia Barcelo
Region Puglia, Italy	45. Francesco Bellino
Universidad de Coruna, Spain	46. Antonio Paz Gonzalez
NEIKER (Basque agricultural research institute), Spain	47. Carlos Garbisu
Flemish institute for technological research, Belgium	48. Ludo Diels
University of Göttingen, forest ecosystems, Germany	49. Michael Bredemeier
Institute for radiological protection and nuclear safety, France	50. Arnaud Martin-Garin
Istituto sperimentale per la nutrizione delle piante, Italy	51. Anna Benedetti /Maria Teresa Dell'Abatte

Continued…

WORKING GROUP ON RESEARCH

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Water agency Seine Normandie, France	53. Pascal Maret
University of Torino, Italy	54. Franco Ajmone Marsan
ALTERRA research institute, Netherlands	55. Coen Ritsema
Faculty of Geographical Sciences Utrecht, Netherlands	56. Victor Jetten
SCAPE	57. Anton Imeson

European Commission and EEA

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DG ENV – Soil Thematic Strategy	Lieve Van Camp

Representatives from other Working Groups

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Organic matter	Stephen Nortcliff
Contamination	Joop Vegter
Erosion	Liesbeth Vandekerckhove/Victor Castillo Sanchez

EXECUTIVE SUMMARY OF THE WORKING GROUPS

SOIL EROSION

Víctor Castillo Sánchez,
Liesbeth Vandekerckhove
Rob Jarman

Introduction

Erosion is a physical phenomenon resulting from the removal of soil particles by water or wind, transporting them elsewhere. A main consequence is that ecological, technical, industrial and socio-economic functions of soil become threatened.

In the 6th Environment Action Programme[1](EAP) among the priorities set for the conservation of biodiversity and natural resources, the Community took the commitment of addressing soil alongside water and air as an environmental media to be preserved and to develop a *Thematic Strategy for Soil Protection.* Indeed**,** it has been agreed that as soil is a finite resource, the Community ought to aim at a sustainable use of the soil, with particular attention to preventing *inter alia* erosion, desertification, land degradation, land-take and hydro geological risks taking into account regional diversity, including specificities of mountain and arid areas.

As a follow up to the adoption of the 6th EAP, the Commission adopted on 16 April 2002 a Communication[2] towards a Thematic Strategy for Soil Protection. On that basis the Commission committed itself to build on actions that will lead to the improvement of the protection of soils. Among these actions, the Commission announced that a Communication would be adopted by mid 2004.

In line with the participation requirement, the Commission carried out a broad consultation involving all *stakeholders,* which has been the foundation of the structure of *Working groups and the Advisory Forum.*

The soil communication COM(2002) 179final), the opinions of the EU institutions and the stakeholder contributions have been used as pillars for the tasks of the different working groups. A large number of requirements and proposals originating from this set of documents have already been integrated in the Mandates.

Stakeholder participation forms an essential part of all stages of the policy cycle. Participation is part of the mainstream policy development process, with a real sense of involvement without allowing policy to be unduly influenced by well organized lobbies.

This Working Group is focusing on policy actions related to the priority area of erosion. The Working Group will assess which is the most appropriate level of intervention (local, national, regional, EU) for the different measures identified as being needed or desirable.

The Working Group is developing technical guidance on key issues previously outlined in the specific "mandate" which was previously consolidated by the Advisory Forum. The Advisory Forum will evaluate the outcome of the working groups and base its opinion on the assessment by the working group.

This Interim Report, elaborated by October 2003, will be the subject of the second meeting of the Advisory Forum.

The Working Group then will draft a report synthesising the outcome of the different tasks (draft final report).

Final decision will be taken by the European Commission after consideration of the consolidated report of the different working groups, in accordance with its right of initiative and then translated into concrete proposals in a transparent way.

Reports will have a wide distribution through the web site of DG Environment and the CIRCA repository. Reports may also be published in part or entirely.

The reports will follow a common structure based on the *"DPSIR model"* as explained in the framework mandate. The reports will contribute to the development of the new Communication on action, the proposal for a monitoring directive and directions for future research.

The Driving forces - Pressures - State - Impact - Responses (DPSIR) framework is a slightly extended version of the well-known OECD-model and is used by different organisations to make assessments on and characterise the main environmental issues.

According to this systems analysis view, social and economic developments exert pressure on the environment and, as a consequence, the state of the environment changes. This leads to impacts on e.g. human health, ecosystems and materials that may elicit a societal response that feeds back on the driving forces, on the pressures or on the state or impacts directly, through adaptation or curative action.

From a policy point of view, there is a need for clear and specific information on all DPSIR elements.

Although it is possible to look at the DPSIR framework as a descriptive analysis with a specific focus on individual elements in the economic, social and environmental system, it is the relationships between the elements that introduce the dynamics into the framework, and bring about changes.

Specific tasks of the Working Group

As the report of the thematic groups must be adapted to the 'DPSIR model', it is necessary to identify:

1. What are the driving forces and pressures causing soil erosion in Europe
2. What is the state of European soils (in terms of soil erosion) in response to these pressures
3. What are the impacts of soil erosion on the sustainable use of the soil and on sustainable development

1 Decision 1600/2002/EC of the European Parliament and of the Council of 22 July 2002 laying down the Sixth Community Environment Action Programme, OJ L242, 22.07.02, p.1

2 COM(2002) 179 final

4. How do we manage the soil to respond to these impacts; Which are the most suitable alternatives and how can we determine them (Measures to address soil erosion and policy recommendations)

And an additional task

5. How can we link erosion with organic matter and contamination Working Group; Secondary threats: Salinisation, compaction, floods and landslides

With this purpose were created the so called "work packages" and the Task Groups (7), or sub-groups inside the working group on soil erosion, in charge of each of them. The work packages are focused on answering the above-mentioned question as well as fulfill the requirements described in the specific mandate presented by the European Commission.

Executive Summary

Task 1 Pressures & Drivers Causing Soil Erosion

1. Erosion is a natural process of landscape evolution, creating micro and macro landforms, and is welcomed as an essential part of our dynamic environment, even though this can impose serious constraints on land use and risks to society. We must enable landscapes and ecosystems to continually evolve.

2. Unnatural erosion is caused by human activities, with point and diffuse sources. The products of this erosion are definitely not welcomed by society – be it the soil that invades our homes, pollutes our rivers and water supplies, causes death on the roads... or the permanent loss of our productive lands.

   Agriculture is the one of the main drivers of unnatural soil erosion, since many farming practices are soil unfriendly and almost half of the European territory is intensively farmed, often in an unsustainable way.

3. Farmers have been driven by market conditions, technological development and the cost of labour to adopt intensive cropping and livestock systems and inappropriate agricultural practices. Erosion caused by headage payments on upland soils, and by the collapse of dairying and conversion to arable on lowland soils, is typical.

4. Land abandonment should reduce pressures on soils. Perversely, in mountain and marginal areas cessation of farming exacerbates soil erosion, as traditional systems of slope and water management breakdown. The loss of people who can sustain these special places is probably irreversible.

5. Forestry can be a major cause of soil erosion, counter-intuitively. The increase of forest area in Europe should benefit soil protection, but changes in forest structure (clear felling, underwood & brash management) and in forest infrastructure (roads, bridges, drainage) accelerate soil erosion – and fire risk.

6. Increasing urban population and tourism boosts the demand for new land development and infrastructures, causing severe loss of the best agricultural land, but also exacerbating erosion in the catchments of these developments because agriculture is shifted to marginal areas. Watercourses, floodplains and the coastal zone are severely compromised by the consequences of soil erosion caused by incompetent spatial planning. The development of urban and transport infrastructures may also have a direct effect on soil erosion during the construction phase.

7. Tourism is now one of the main economic sectors across the EU and soils are suffering from erosion following compaction, nutrient enrichment, sealing, and excavation - in mountainous areas with winter sports, on the coast and in open spaces everywhere…

8. Coastal erosion is a complex process driven by a deficit in sediment load as a result of dams built upstream of the major rivers, mining activities, development of coastal infrastructures (e.g. harbours and protective breakwaters). Other causes are pressure of tourism on fragile systems like sand dunes and the demand for new leisure infrastructures, disrupting sediment transport.

9. Soil erosion affects large areas in the accession countries, dating from the period prior to the economic and political changes (1980s and 1990s) but still significant today. Although certain efforts have been made, greater investments in soil erosion mitigation measures are indispensable.

10. Natural events like droughts and wildfires reduce the vegetation cover, increasing the risk of erosion. Storms, flooding, bank erosion and landslides affect the most sensitive areas and may be quantitatively important. Climate change is expected to increase wind erosion in the drier periods and more erratic storms will increase water erosion. Sea level rise and increased frequency of storm surges will also have severe impact on coastal erosion.

11. Existing policies have been assessed for their impacts on soil erosion at the EU and member state levels. Information is scattered and incomplete. We need to improve documentation on implemented policies, and develop a methodology to analyse the impact of policies at different spatial scales.

12. Several policies have been analysed at European level:

- Forestry
  - Afforestation regulation 2080/92: reduced erosion when planting on slopes and arable land, but erosion increased by improper site preparation techniques and extensive afforestation of grasslands.
  - Council Regulation No 2158/92 on protection of the Community's forests against fire (OJ L217, 31.7.1992): has contributed to improve the efficiency of forest fire prevention and control systems.
  - Rural Development Policy (Council Regulation (EC) No 1257/1999). Forestry measures include

afforestation of agricultural land, improvement of the multifunctional role of forestry and improvement of the protection value. It needs to be assessed to what extent these measure are applied in areas under mid/high risk of soil erosion.

- Natura 2000: Soil protection is one of the elements considered under habitat protection and taken into account in the delineation of the Natura 2000 network. In some countries, considerable part of the forests are included in Natura 2000.

- Agriculture
  - Agri-environmental Regulation 2078/92: the area included in such programmes greatly varies from one country to another and its allocation does not necessarily coincide with those parts of Europe where the areas of either greatest nature conservation value or greatest agricultural pressures on the environment are found.

  Problems implementing the agri-environment schemes range from farmers perception to conflicting measures within the CAP. Good knowledge of local conditions is a prerequisite to increase effectiveness of these measures.

  - CAP reform. Agenda 2000: little monitoring or evaluation work has been completed. In general, it seems to slowly improve environmental issues already dealt under 1992 reform.

- Transport.
  - The major environmental concern being emissions, protection of soil against soil erosion is only a secondary issue, which is addressed indirectly through the protection of natural areas.

- Protection of specific areas: mountains and coast
  - Alpine Convention and related Protocol on Soil Protection: increased public awareness of the environmental problems, in particular to practices enhancing soil erosion.
  - Communication regarding Integrated Coastal Zone Management (ICZM) COM(2000)547: could be an important instrument for land use planning of coastal areas 13. The pressures and drivers causing soil erosion in Europe are well understood. It is the poor integration of policies that is the problem.

13. The pressures and drivers causing soil erosion in Europe are well known. It is the poor integration in policy that is the problem.

Task 2 Nature & Extent Of Soil Erosion In Europe

1. Soil erosion is widespread throughout Europe. Soil erosion is caused principally by water and wind processes, naturally and/or unnaturally by human activity. Spatial variation in soil erosion across Europe relates to climate, topography, hydrogeology and soil characteristics; and to human activities in land use. The ebb and flow of cultures across Europe has left a legacy of land alteration and exploitation that will cause long lasting soil erosion problems.

2. Many programmes for mapping soil, evaluating soil, defining risks and capabilities and specifically for monitoring erosion have been undertaken at various scales in Europe, at national and regional level. The European Soil Database provides a harmonized basis for identifying the areas most at risk of erosion and for examining the processes responsible. This coupled with CORINE land cover, a suitable digital elevation model and climate data can provide a good basis for modelling erosion. The Pan European Soil Erosion Risk Assessment (PESERA) project is currently calibrating a spatial model to quantify soil erosion by water and assess its risk across Europe. The PESERA model seems to be a promising tool to improve the quality of information and enable better soil protection through land use planning on the base of risk assessments.

3. The results of studies from 10 European countries have been assessed and the following conclusions drawn:

   - The Mediterranean region is particularly prone to erosion due to long dry periods followed by intense rainfall on steep slopes with fragile soils.
   - N & W Europe is particularly prone to erosion due to unstable post-Ice Age topography, immature soils and extremes of rainfall and snowmelt.
   - Rates of soil formation are very slow, so that losses of soil >1 tonne/ha/yr can be considered as irreversible over a period of 100 years.
   - Losses of soil at 20-40 tonne/ha/yr in individual rainfall events every 2-3 years are frequent.
   - Extreme rainfall events can cause losses of soil >100 tonne/ha/yr.
   - Wind erosion in SE England has been recorded at 21 tonne/ha/yr over a 30 year period.

4. Erosion by water and wind is irreversibly degrading the soils in many parts of Europe. In parts of the Mediterranean region, soil erosion has now ceased, as zero soil remains to be eroded…

5. Runoff is the most important cause of severe soil erosion, so that measures that reduce run off are crucial to soil protection.

6. Loss of topsoil is the dominant effect of water and wind erosion, and is especially problematic as the soil loss may not be visible to the land user, and it is only the off-site impacts that reveal the story.

7. The typical perception by land users/farmers of soil erosion is that it only occurs as gullies – so if you cannot see gullies then there cannot be any erosion…the notion that soil erosion occurs on flat land is alien !

8. Insidious erosion by small events leads to gradual accumulation of soil and fine particles in ‘sumps’ in the landscape (hollows, field edges, stream banks, even instream) and this is often not observed – until a large storm mobilises these sumps and causes a massive soil transport event.

9. The movement pathways of soil (and the attached

nutrients, pesticides etc) across the landscape become highly visible once they have been pointed out to you in the field. Awareness of soil movement amongst land users is poor.

10. There are many forms of erosion that land managers must consider as risks and that they must pre-empt by adjusting their land use : Rainwash, Rills and runoff, Gullying, Banks of watercourses and lakes, Coastal erosion, Snowmelt, Wind blow, Floods & landslides, mudflows, subsurface & groundwater erosion.

11. In 1995, 12 million ha = 10% of land in Europe was strongly degraded by water erosion. Climate change is already accelerating these erosion processes.

12. The development of user-friendly soil characterisation tools and erosion risk assessments, coupled with a new approach to determining land capability and vulnerability, is essential if soil erosion is to be prevented.

Task 3 Impacts Of Soil Erosion

The concepts of soil functions and soil quality provide a sound basis for assessing, predicting or measuring the impact of soil erosion on sustainable development and sustainable use of soil. Soil quality is an intuitive concept that refers to how well the soil performs its functions. Soil quality cannot be measured directly, so the use of indicators is needed. Indicators are measurable soil attributes that provide clues about how well the soil can function. *We recommend the development of soil surveys and monitoring programmes for collecting a minimum data set of physical, chemical and biological variables that allow us to quantify soil quality and implement a soil erosion indicator system in Europe*

Soil erosion has an impact on the soil itself. The loss of fertile topsoil due to erosion has serious effects on crop yields and the disruption of soil functions, as it reduces plant rooting depths, removes nutrients and reduces water holding capacity potential. Depletion of soil's filter and buffer capacity and potential accumulation of pollutants in local deposition areas are also on-site impacts caused by soil erosion. Decrease in soil biodiversity is another and very important on-site impact of soil erosion. Decline in soil biodiversity affects soil turnover, degrades soil structure, increase crusting, reduces infiltration rates and exacerbates surface runoff and erosion. But our understanding of these relationships is still limited, so this is an area for development of further research.

The on-site effects are usually assessed from an economic point of view, in terms of economic losses derived from the decline in crop yield and changes in the overall input use efficiency. *With the introduction of the concept of soil quality, more attention is being paid to the assessment of the impacts of soil erosion on the ability of the soil to perform its ecological and human-related functions.*

Soil quality indicators refer to measurable soil attributes that influence the capacity of soil to perform crop production or environmental functions. With such indicators the impact of soil erosion on the soil itself could be estimated. The rate of erosion, which is dependent on many things and is variable in space and dynamic in time, is not a good indicator for this purpose

A soil loss tolerance for specific sites could be useful. It should take into account the functions of the soil, soil properties, position of the site in the surrounding landscape, and potential off-site impacts. The points mentioned are to be investigated by an expert and individually for each specific site. Regional or nation-wide assessments would be inappropriate or misleading.

The off-site impacts of soil erosion are closely related to the processes of transport and sedimentation of soil particles. Offsite impacts of erosion are sedimentation in downstream areas, decline of water quality due to diffuse pollution and eutrophication of water bodies and changes in air quality. There is a vast amount of research on water quality impacts, but not much on changes in air quality due to the transport of particulate matter in air (e.g., by wind erosion) and the emission of green house gases into the atmosphere.

Off –site damage relating to soil erosion by water can be, given the short-term economic consequences, far more important than on-site damages. Off-site impacts of soil erosion could be assessed by the siltation rates and eutrophication of water bodies and by analysing the expenditures for removals of sediment deposits in built up areas (traffic routes, houses).

The severity of on-site and off-site impacts is indicative for the level of sustainable use of soil resources and for the efficacy of soil protection measures as well.

Many criteria and indicators are known to assess the effects of water and wind erosion. The problem with many existing and often mentioned criteria and indicators is that they cannot be monitored intensively for larger areas or regions. Criteria to assess soil erosion impact on sustainability of soil resources must be based on the induced changes, while the indicators should be generally accepted throughout Europe and should be easy to determine using a standardized methodology.

There are no comprehensive, Europe-wide studies of the economic impact of erosion and available data suggest this is a major challenge. About 17 % of the total land area in Europe is affected to some degree (source: EEA; average to be considered very carefully due to spatial variability). Yearly economic losses in affected agricultural areas in Europe are estimated at around 53 EUR per ha, while the costs of off-site effects on the surrounding civil public infrastructures, such as destruction of roads and siltation of dams, are estimated to cost 32 EUR per ha. *We recommend to assess the economic impact of soil erosion at a European level by collecting data obtained by local or regional studies, that are carried out by regional or provincial authorities, or even at a local community level.*

Task 4.1. Measures to combat soil erosion

1. Measures to combat soil erosion cover a wide range of actions to be applied in a wide range of scenarios, depending on the driving forces, threats, and target areas. Specific measures can be classified according to a non-excluding number of interrelated

approaches:

- Source oriented measures and (off-site) impact oriented measures.
- Prevention, mitigation, and restoration measures.
- Activity-specific measures: agriculture, livestock management, forestry, transport and construction infrastructures, etc.

Furthermore, measures can be regional, local and site-specific to deal with specific environmental and socio-economic conditions.

2. The general principles underlying the proposed measures to combat soil erosion are:

- Production systems should be adapted to land capability and soil suitability.
- Prevention measures should rely on sustainable land use and management; sustainability of land use systems needs to meet both environmental and economic conditions.
- Soil protection measures need to be attuned to water management programmes.
- The promotion of a protective vegetation cover and/or organic debris (plant residues, litter) cover.
- The optimisation of soil organic matter levels.
- The promotion of soil water infiltration.
- The principles of ecological restoration should feed restoration programmes to combat the consequences of soil erosion.
- An integrated management approach should feed land use planning to prevent coastal erosion, bank erosion, landslides, gullies and debris flows.
- Education and training of land users; increasing awareness of short-term and long-term environmental and economical benefits of controlling soil erosion.

3. Our recommendations on measures to combat soil erosion are classified according to the activity involved and the stage of the degradation driving forces. The latter may still be active (prevention and mitigation measures) or may have ceased after degradation (rehabilitation and restoration measures):

1. Prevention and mitigation measures

1.2 Agriculture

1.2.1 Agricultural practices

a. *Land use planning:* goes from the identification of best and marginal agricultural lands, relating major land use to land capability, to the management of abandoned agricultural lands to avoid further degradation.

b. *Soil management practices:* mainly involve the improvement of soil properties that positively contribute to reduce erosion, by maintaining proper soil organic matter levels, by minimising or adapting soil tillage (the level depending on soil situation and climate), … and by reducing soil compaction by machines.

c. *Landscape elements:* involves the preservation and maintenance of plant-covered field edges (especially of those which run along the contour), soil and water conservation structures (terraces,) and hedge rows and groves.

1.2.2 Rural landscape engeneering to support agricultural practices: go from proper size, shape and direction of agricultural fields and farm tracks, to rural engineering measures to control runoff (secondary measures to control symptoms) and the construction of new landscape elements.

1.3 Livestock and grazing management: include, amongst others, the establishment of the proper stocking rate, kind of grazing animal, season and duration of grazing for each rangeland, the introduction of integrated management systems and of management plans specifying when prescribed fire should be used and how the burned areas should be grazed, and prescriptions on the access to communal use of public natural pastures.

1.4 Forestry

1.4.1 Criteria for afforestation/Forest management: go from minimising impacts on soils of site preparation techniques for afforestation to silvicultural actions aimed at improving stand structure and functioning.

1.4.2 Fire prevention and post-fire management: implies setting up a programme for preventing uncontrolled burnings by awareness raising in order to modify the human behaviour of the rural population in the use of fire, avoiding savage logging in erosion-prone sites, unless strong soil conservation measures are provided.

1.5 Transport, construction and other sectors:

1.5.1 Land use planning: involves the identification of areas at risk of floods, landslides, and debris flows, bank erosion and coastal erosion, which may be triggered by construction works. The principles of an Integrated Coastal Zone Management are explained in the report.

1.5.2 Prevention and mitigation measures of erosion related to transport and construction structures are proposed. Erosion of the coast and shores of lakes and rivers (bank erosion) can be tackled by means of 'hard' engineering techniques, i.e. construction of solid structures to fix the position of the coastline (e.g. revetments, breakwaters, groins, etc.) or 'soft' techniques, i.e. working with natural processes accepting the dynamic nature of the coastline (e.g. sand nourishment, vegetation, etc.).

2. Rehabilitation and restoration measures*:*

2.2 Restoration to combat soil erosion should be designed as ecologically sound, multi-purpose measures, adapted to the new social demands. The principles of an ecological approach are explained in the report.

2.3 *Post-fire soil conservation and restoration:* includes the application of emergency soil conservation treatments in erosion-prone areas, using on site slash as mulching materials, and the promotion of fire resilient plant communities and forest restoration.

2.4 *Rehabilitation of degraded soils:* may involve the application of exogenous organic matter (EOM) respecting the precautionary principle to maintain soil functions on a sustainable basis. Its ability to reduce erosion is however less important than soil cover and

land management practices.

Task 4.2. Policy Options for Prevention and Remediation

1. Soil erosion is a common problem in the European Union. However, distinguishing geological and climatic features of each Member State often lead to distinct policy priorities for tackling soil erosion. In general, northern European countries are more concerned with the off-site impacts of soil erosion, which can cause eutrophication in water courses, while Mediterranean countries are more concerned with desertification. Therefore, although the aim to reduce soil erosion is common, the answers lie in national solutions adapted to each country's needs.

2. As far as soil protection is concerned, a common issue amongst most European countries is the lack of specific legislation to combat soil erosion. Isolated and dispersed regulations on this matter may be found within the framework of other regulations focused on different subjects, such as protection of water quality and highways and roads. Only Germany, Austria Switzerland and Spain have a specific regulation for soil protection. In Switzerland, there are legal guide values for soil erosion.

3. In most of Member States, the principal instruments to tackle soil erosion are economic instruments in the form of cross-compliance (sanction) and agri-environment schemes (incentive). Member States are distinct in how they control soil erosion through this means. Most schemes have indirect measures - that is, their first purpose is targeted at conservation, landscape or biodiversity, not soil; a few Schemes also have specifically targeted soil measures. Many Member States have voluntary Codes of Good Farming Practice (GFP) which give advice on soil conservation measures. In general terms, good progress for soil conservation has been made in the agricultural sector through the agri-environment schemes and the introduction of Codes of Good Farming Practices. *We recommend that Member States should identify the soil resource more clearly as an objective of agri-environment schemes and increase the profile of soil within the Codes of Agricultural Practice. Agri-environment schemes need to be targeted on particular areas that are vulnerable to erosion and support in the form of advice and guidance to farmers is also important to ensure their effectiveness.*

4. A number of EU directives, regulations and agreements that have the provision to tackle soil erosion, have been identified in the text. For example,

- The Water Framework Directive requires the "good status" of all water bodies by 2015. Where this objective is not achieved and the reason is identified as diffuse pollution by soil, Member States will have to take action to control it. The links between diffuse pollution and soil erosion, and between the WFD and the STS must be made.
- As a result of latest CAP reforms and the growing importance of environmental principles introduced by the establishment of cross-compliance, soil protection has been, to some extent, addressed by the agricultural sector. Furthermore, rural development programmes foresee a large number of further specific measures to prevent soil erosion via agri-environment schemes, which should produce a higher level of soil protection in these schemes.
- Through the Kyoto Protocol, there may be a possibility to encourage soil carbon sequestration which, as well as combatting climate change by reducing atmospheric carbon, would have a beneficial effect on reducing soil erosion.

5. *The WG identified different steps towards a European policy on soil protection: 1) Member States take a closer look at what is currently available to them in the form of existing European directives etc. to address erosion; 2) Member States identify the gaps in current directives in order to define the need for new legislation; 3) The Commission develops a soil framework directive.* Where it is envisaged that new measures are to be implemented in the framework of other policies, Member States must be aware of the importance of farmer support, in order to succeed in reaching the environmental requirements. Given the limited financial and human resources, and the fact that national initiatives already exist, member states should be encouraged to *rearrange and optimise budgets,* rather than incurring additional expenses. Furthermore, costs, effects and benefits of the measures have to be monitored

6. *We recommend that the Commission should stimulate the process of the promotion and establishment of technology transfer programmes, structure modernisation plans, training programmes and research and development actions.*

7. It will be important for Member States to identify the gaps in national policies that control soil erosion and consider the following new recommendations:

   - *Raise awareness of soil erosion, and suggest activities to reduce the risk.*
   - *Encourage measures to increase the soil water retaining capacity of the land in areas vulnerable to flooding.*
   - *Provide economic incentives (such as tax benefits, subsidies, etc.) to farmers who use sustainable production systems.*
   - *Set up a member state soil conservation service to ensure soil policies are implemented.*
   - *Explore the merits of Intergrated Farm Management, Organic Farming and Conservation Agriculture as systems that contributes to soil protection trough sustainable farm management.*
   - *Introduce and practice the Integrated Coastal Zone Management approach.*

Task 5 Links with Organic Matter and Contamination Working Group and Secondary Soil Threats

Salt-affected soils occur both naturally and as a result of irrigation practices which permit the mobilization of salinity within the soil body and the transport of salts and/or Sodium (Na) to new locations. Salinity also poses a major management problem in many non-irrigated areas where cropping relies on limited rainfall.

Most common identified driving forces inducing salinization and sodication in Europe are: increasing demand for irrigation water, increasing use of low quality waters, groundwater overexploitation and marine intrusion into freshwater aquifers. Associated impacts derived from climatic change may exacerbate soil salinization and sodication in some regions of Europe. Within Europe, 26 countries are more or less affected by salinization and sodication, However, information about the current status of salinization and sodication in Europe is both not complete and contradictory depending on the sources used.

Salinity usually has negative direct effects on crop yield by reducing the ability of plant roots to absorb water. It also affects the structural and hydraulic characteristics of soil with subsequent loss of aggregate stability and reduction in infiltration rate. As a consequence, soil erodibility increases as well as runoff and soil loss by erosion

We recommend:

- *The urgent implementation of a netwok in European countries affected or potentially affected by salinization and sodication, in order to collect updated and reliable information on the status of salinization and sodication in Europe, to identify areas threatened by salinization and sodication, and to monitor indicators of salinization and sodication (link with Research and Monitoring WGs).*

- *The application of models predicting transport of water and solutes for selection of management strategies (i.e. alternative irrigation methods and scheduling, calculation of leaching requirement, conjunctive use of different irrigation waters, amendments, etc.) leading to environmental protection, to the rational and sustainable use of soils and water resources through prevention of the hazard of soil salinization/sodication is also necessary.*

- *To increase knowledge of the soil hydraulic parameters/functions is necessary to validate and calibrate simulation models and to develop reliable management scenarios (link with WG Research).*

Soil compaction induced by large-scale equipment in agriculture is of growing concern. The demand for tractive power and machine power increase with intensified production practices. As higher tractive power or bigger bunker capacities often result in higher wheel loads, heavy wheel traffic under wet conditions increases the risk of irreversible harmful damage to the soil structure to greater depths.

Soil compaction directly affects plant growth and yield capacity as it has an impact on water and air storage capacity, oxygen supply to roots, and rootability. Also soil functions related to the environment e.g. soil air- and water conductivity and heat balance are affected. Changes in nutrient cycles due to altered soil chemistry and increased greenhouse gas emissions can also arise from soil compaction. The reduced infiltration capacity e.g. for precipitation water may also lead to a higher erosion susceptibility. Especially subsoil compaction occurs to be very persistent and is difficult to alleviate. To safeguard the ecological soil functions and the functions linked to human activities on a sustainable basis, measures against harmful soil compaction are required.

About 32% of the subsoils in Europe are estimated to be highly vulnerable to subsoil compaction and approximately another 18% moderately vulnerable, but no precise data are available. We propose that the key responses to compaction problems are effective precautionary measures for prevention of compaction, which should be addressed by policy instruments. For the avertion of harmful changes to the soil, concrete measures should be selected in accordance with the competent agricultural and environmental advisory bodies, together with the farmer. We recommend that Community policies should increase the focus on the compaction problem, and simultaneously work out further guidelines to prevent traffic-induced subsoil compaction, and develop guidelines for good agricultural practice in relation to soil compaction. Further research should emphasis on improvements of prevention techniques and applicable practices in arable cropping. In general a more holistic approach in soil compaction research would be needed, bringing together soil scientists, agricultural engineers, agronomists, economists, industries and field practioners, to improve the onfarm practices and the rural ecosystems.

Floods are climatological phenomena influenced by geology, geomorphology, relief, soil and vegetation condition. Certain soil threats (erosion, sealing, compaction) to soils have an impact on the occurrence of flooding. Flooding can wash out enormous quantities of fertile topsoil and deposit the sediments in other parts of the territory, at great cost to socio-economic and environmental resources. Thus, soil protection measures and flood protection schemes can have huge benefits beyond the simple protection of soil.

We recommend the adoption of land use planning schemes in river basins preventing rapid runoff both in rural and urban areas, and determining land use restrictions on flood-prone areas. A transnational effort should be made to restore river's natural floods zones leading to fl ood mitigation and to ecological benefits .An important step could be the harmonisation of soil protection, flood prevention and spatial planning policies. This is an essential output of the Water Framework Directive that must be integrated with Soil Protection objectives.

Landslides are major natural hazards, claiming thousands of lives and millions of Euro in lost property each year in almost all mountain, river basin and coastal areas. Environmental degradation caused by human interference with nature and by climatic change increases the hazard potential. Growing population density and mobility associated with urbanisation, expanding infrastructure and industrial facilities and tourism expose more people and more property to hazardous events and thus generate increasing risks

We recommend that the strategy to meet these threats should be based on two principles:

- *. Society has to become better prepared for the impact of disasters.*
- *. Society has to proceed from reaction to and protection against hazards, to the management of risk*

by integrating risk prevention strategies into sustainable development programmes.

In order to achieve these objectives, significant progress in hazard and risk assessment, risk reduction and capacity building is considered essential.

Soil organic matter is degraded by erosion processes. The organic matter loss is mainly correlated with the removal of the topsoil by water erosion, its oxidation through excessive aeration caused by intensive soil tillage and also with the degradation of soil structure through soil compaction. Declining soil organic matter contributes to higher level of soil erosion that, in turn, hampers the establishment of plant cover and the replenishment of organic matter.

Soil management practices that are good for organic matter conservation and to combat erosion have to be identified and integrated into agri-environmental measures. Conservation practices and sustainable farming management systems will play an important role in stabilizing and increasing organic matter. The application of exogenous organic matter (EOM) may improve the resilience of soils against degradation processes. Long-term improvements, however, can only be achieved if the soils are managed in accordance with the precautionary principle to maintain soil functions on a sustainable basis. Exogenous organic matter should only be applied if there are no detrimental impacts on soil functions or harmful off-site effects.

Soil erosion and the delivery of contaminants to water and air influence the quality of surface waters, groundwaters and air, and, in turn, freshwater ecosystems and human health. In this respect, soil erosion on land and the erosion of river banks have important implications for the ability of Members States to implement and comply with the EU Water Framework Directive (2000/60/EC).

We recommend that, in order to address the role of soil erosion and sediment delivery in the contamination of water and air, integrated soil-sediment-water-air policies need to be developed.

Task 6 Desertification

Desertification is land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities. European Mediterranean countries have been identified as sensitive areas to desertification because of the occurrence of particular conditions over large areas:

- Semi-arid climatic conditions affecting large areas, seasonal droughts, very high rainfall variability and high intensity rainfall.
- Poor and highly erodible soils, prone to develop surface crusts.
- Uneven relief with steep slopes and very diversified landscapes.
- Extensive forest coverage losses due to frequent wildfires.
- Overgrazing
- Crisis conditions in traditional agriculture with associated land abandonment by rural populations and deterioration of soil and water conservation structures,
- Unsustainable exploitation of water resources leading to serious environmental damage including chemical pollution, salinization and exhaustion of aquifers.
- Concentration of economic activity in coastal areas as result of urban growth, industrial activities, tourism and irrigated agriculture.

Land degradation has not spatial and temporal confinement. In Northern Europe under northern boreal and subarctic climate conditions there are examples which are similar with desertification known from Southern Europe.

The drivers of desertification always include both the human and the biophysical factors. Neither dimension can be regarded as the sole triggering factor. Land management practices and land use changes leading to overgrazing, deforestation, forest fires, and secondary salinization are among the most recognized causes of land degradation and desertification.

Assessing desertification is a complex task and there is a lack of a holistic methodology that enables this to be done at the global and regional level Assessment methods currently being used by the National Action Programmes (NAPs) have looked at a hypothesised sensitivity to desertification but this is different from detecting and assessing actual current trends in desertification. At present, most evaluations rely on soil erosion estimates, which are a relevant desertification symptom, but not the only one.

The assessment of sensitivity to desertification and actual desertification itself is an issue addressed by European scientific research projects whose importance increased after the United Nation Convention to Combat Drought and Desertification (UNCCD) committed affected countries to elaborate and approve a National Action Programmes (NAPs).

Desertification is a complex process of simultaneous degradation of soil, water resources and vegetation, which can affect natural, semi-natural and agricultural systems, as well as other human activities. Collectively, this degradation leads to a loss in resilience, soil quality and in ecosystem integrity and health. This results in a loss of both ecological and social capital.

Desertion and desertification are related problems in rural areas. Whether causes of land abandonment are natural or socioeconomic is still subject to debate. Land abandonment occurs because of external driving forces, such as market changes, or as a consequence of land degradation which lead the system to cross some irreversible threshold, such as the critical soil depth for plant growth.

Aridity, drought and desertification are distinct, but closely related, concepts. In addition to natural irregularities on water supply associated to climatic conditions, the public perception of desertification in Mediterranean areas has been heightened by water resources shortage arising from the human induced water problems.

Successful programmes to address desertification should encompass all the complexity of this problem, including its physical, ecological, sociological and economical

components. Moreover, they require reliable instruments of diagnosis and forecast, allowing for the application of the right treatments at the right places

Combating desertification includes the application of sustainable systems of exploitation of land resources and ranges from the prevention and/or reduction of land degradation to the restoration of degraded/desertified lands.

Prevention and reduction of land degradation should be tackled through linked forecast and integrated land use planning actions. The implications for management of these actions should be refined at the local scale.

Once some thresholds are exceeded, even if desertification-driving forces are reduced, degradation can only be reversed by restoration actions. Since degr aded systems are characterised by net losses of resources, restoration in desertification-prone areas is conceived to increase the conservation and capture of such resources. These goals should be achieved by restoring ecosystem functioning.

To avoid, reduce, limit and mitigate land degradation and desertification it is needed to adapt both research and policies to the many variable scales at which socio-natural landscape dynamic operate. More recognition should be given to the importance and responsibilities of all social sectors involved in the study and control of the desertification processes.

Collaboration and co-operation between European organisations and institutions should be established in order to promote initiatives concerning joint programmes, financial aspects and technology transfer for developing pilot research projects on soil degradation processes and on mitigation measures.

Task 7 Monitoring

1. Monitoring soil erosion should be based on an *indicator based approach.*

2. The *area at risk of soil erosion* is proposed as an indicator of *state* of soil erosion. The indicator should be derived from:
   - An assessment of soil erosion risk derived from an appropriate tool (e.g. an erosion model);
   - Measurements of actual soil erosion rates (t/ha/y) at a limited number of sites.

3. A risk assessment tool/model is needed for the following reasons:

   - Selection of measurement sites (plots and catchments): selected sites should have a moderate to high erosion risk and be representative for an agro-ecological zone;
   - Interpolation of results from local measurements to larger areas: to assess the state of soil erosion in areas where no measurements have been done while accounting for local conditions of the factors affecting soil erosion;
   - Scenario analysis: to predict soil erosion under different land uses and/or climate change.

4. At a European level, the use of a unique methodology is recommended in order to get comparable results. The use of national or regional assessments may be useful to verify the result of a European model (and vice versa).

5. In order to produce reasonable results, modelling requires:
   - Input data;
   - Calibration and validation.

6. The *input data* for a soil erosion model consists of static and dynamic data.
   - Static data are to be determined at the start of the monitoring process (no further monitoring is required), and consist of:
   - Soil data;
   - Topographical data.

The accuracy requirements of these data depend on the type of model and the scale of the modelling (European or national/regional). More details are given in the report.
   - Dynamic data requiring specific monitoring:
   - Land use and land management data;
   - Climatic data.

The accuracy of these input data will largely determine the quality of the resulting indicator, e.g. its ability to show the effects of local management interventions resulting from policy measures (action driven monitoring). Different data collection methods are discussed in the report. The recommended time interval for the measurement of land use data is once in ten years. For climatic data, long term averages are necessary.

7. Calibration and validation requires *measurements of actual soil erosion rates (monitoring sensu stricto).* We recommend that first use should be made of existing sites and only in cases where existing data are not sufficient should additional sites be selected.

8. Measurement should be carried out at the plot scale and at the catchment scale (nested approach). At the catchment scale a combination of methods can be used, as discussed in the report:
   - Mapping visible erosion features;
   - Continuous measurements of sediment transport at the outlet of small catchments;
   - Measurements of sediment deposition in ponds and lakes.

As soil erosion is highly variable in time and space, soil loss measurements should be continuous. From these long term measurements, averages can be determined, e.g. over a period of 10 years.

9. *Actions to be taken* to set up a European soil monitoring system are:
   - Use existing measurement data on soil erosion and apply existing risk assessments tools (models) using the best available input data to identify areas at high or moderate risk of soil erosion. These data should provide the *baseline (t0);*
   - Make an inventory of existing measurement sites;
   - Check whether existing sites are representative with respect to soil erosion risk and within agroecological

zones;
- Select additional sites if necessary;
- Start collecting new data at all sites (e.g. over a period of 10 years);
- . Validate and calibrate the model using the collected data;
- . Improve model concepts;
- . Produce new model output: these data should provide the first trend in soil erosion *(t1-t0)* with respect to the baseline (e.g. t1-t0 = 10 y);
- . Select additional sites if necessary.

The process should be seen as an iterative one.

10. In areas susceptible to salinisation and sodication, monitoring of the following parameters is recommended:
- Electrical conductivity as an indicator of salinisation; and
- Sodium Adsorption Ratio (SAR) as an indicator of sodication.

11. Monitoring on site impacts of soil erosion and salinisation/sodication requires the monitoring of soil quality indicators.

A list of potential parameters is given in table 1. However, these parameters and data are less relevant at a small, e.g. European scale but are more relevant at large, e.g. regional or local scales.

ORGANIC MATTER AND BIODIVERSITY

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Importance of organic matter and biodiversity both in the context of soil properties and functions

Soil organic matter

Organic matter is both an important soil constituent (even if relatively minor in quantity) and the main source of food and energy for soil organisms. In many respects, the role of soil organic matter is indiscernible from biological functioning.

1. Origin and composition of Soil Organic Matter (SOM)

Soil organic matter has a very complex origin, resulting in a diverse composition. It includes living organisms present in soils and the dead organic material. During their decomposition above ground organisms are the main sources of SOM constituents. These constituents can be particulate, colloidal (humus) or dissolved. Whilst polysaccharides secreted by organisms have a well-known structure, the humus structure is still relatively unknown.

The origin of OM is mainly related to the biomass production in agriculture, forests and natural and semi-natural systems. However, exogenous OM recycling is becoming an important source comprising animal slurries and manure and other biowastes. (Task 4). All the OM entering the soil contributes to the carbon cycle.

2. The dynamics of SOM turnover are partly controlled by the redox state of the soil.

Anerobic and anaerobic conditions result in very different mineralization products (some of them being greenhouse gases, such as CO_2, CH_4 and N_2O).

SOM fractions have very different residence times ranging from considerably less than 1 year to more than a thousand years. Differentiation between such fractions or pools, which have different composition and different properties and perform different functions, is important.

3. SOM influences soil physical, chemical as well as biological properties, the most important properties being:

Physical properties: porosity colour, water retention, binding of compounds in and stabilisation of soil aggregates, habitat for living organisms. In the clay-humus association, SOM and living organisms intervene from micron to centimetre scale in the soil structure (nano- to macro-aggregate);

chemical properties: exchange capacity, complex (chelate) formation, buffer capacity for pollutants and pH, source of nutrients;

biological properties: SOM as the nutrient and energy source, essential for biological functioning and biodiversity

4. Physical, chemical and biological properties together determine important soil functions.

In the past before the technological progress of artificial fertilisers, SOM was at the core of soil fertility for biomass production. This is still the case for low input agriculture, forestry and organic agriculture. SOM may play a key role in soil fertility in sustainable agriculture.

The most important role of SOM, however, concerns the many environmental functions, which are linked to water, air and ecosystem quality.

Because of the key role in soil aggregation and soil structure, SOM is strongly influential in determining water dynamics; its role as a buffer strongly influences the water quality. SOM is important in the N cycle, where its mineralization has a positive effect in providing nitrogen for plants, but may contribute negatively to environmental quality by NO_3 pollution of groundwater and surface water and to N_2O emissions to the air, under unbalanced conditions. SOM is also central to the C cycle with either carbon accumulation, production of living organisms or CO_2 emission.

5. Some SOM functions are related to the three important international conventions on biodiversity (UNCBD), desertification (UNCCD), and climate change (UNFCCC).

The relations between SOM and biodiversity have been briefly addressed above, and include: source of energy and nutrients, soil structure and diversity of habitats.

SOM has strong links with erosion (by wind or water), which is frequently part of the desertification process. Soil cover by vegetation and the level of SOM are linked and play key roles in both the degradation processes (erosion and desertification), in the prevention of the onset of desertification and in remediation practices.

Concerning the Kyoto Protocol, SOM is the main reservoir of C of the continental biosphere, and it can be either a source of CO_2 (and other greenhouse gases) during mineralization, or a sink when carbon sequestration is favoured.

6. The great diversity of situations.

The SOM content and dynamics vary considerably from place to place, depending on several factors, some of which are identified by task group 2. These include climatic factors (e.g. temperature and precipitation), land cover and land occupation. A consequence of the climatic differences is the C accumulation in the soils of the northern part of Europe or with elevation or in contrast with the often low C content of soils of the Mediterranean area. Variations due to land cover and land occupation are the often high C content of grassland and forest soils. Similarly cultivation of natural soils will normally induce important losses of C, which are related to land perturbation by cultivation and only limited OM return to the soil. Some changes in land use and agricultural practices (task group 5), for example the increased use of exogenous OM (task group 4) can maintain or increase the SOM content.

7. Important policies and impacts

It is essential that SOM is considered not only as C, carbon (in the meaning of Kyoto Protocol) but also as one of the key factors influencing soil quality, soil health and soil biodiversity.

Task group 6 presented the main policies, which are available to maintain and change the quality and content of SOM. Forest and agricultural managed land form important parts of the land cover of Europe. Consequently many of the proposed actions will involve changes in agricultural policies (task group 7). The priority must be to seek the win-win situations, which increase SOM but also soil biodiversity, soil quality, and decrease soil degradation (erosion, desertification). Such reforms linking to soil quality and soil organic matter have to be part of the CAP reform but farmers should more easily accept them because they concern both their resource and their capital.

Recommendations concerning Soil Organic Matter

1. Quantitative relationships between SOM (total C and well defined OM fraction) and soil properties, derived from monitoring data might be generalised using pedo-transfer rules.
2. Clearer relationships between soil properties and functions are needed in order to establish whether it is possible to determine threshold levels for SOM.
3. Recommendations for optimal SOM management must be made in a regional context, due to the great variability in soils and complex relationships with environmental and cultural factors.

II The Soil biodiversity

Within the task of the working group, the term "Biodiversity" is used in its widest sense (Biodiversity *sensu lato*), which means that we are not only interested in the diversity of genes, species, ecosystems and functions, but also in the metabolic capacity of the ecosystem.

Soil biological activity

Soil organisms are a major component of all soils. Often their biomass is low compared with the mineral or humus fraction, but the organism activity is absolutely crucial for a functioning soil.

Political importance of soil biodiversity

The importance of soil biodiversity is acknowledged in international treaties (UN-CBD, UNFCCC, UNCCD), by international organisations (OECD, FAO) and by national governments. The UN treaties have their own International and National Action Programmes, in which the role and protection of (soil) biodiversity is addressed. Soil biodiversity needs to be protected because of its intrinsic value, and its ecological functions in the soil.

Soil biodiversity and sustainability

Protection of soil biodiversity is necessary to maintain the sustainable use of the soil.

Important functions of soil organisms

Soil organisms mediate the chemical conversions in the soil. Without the organisms, soil would be a dead material. The actions of the organisms comprise:

- mineralisation of organic material
- nutrient cycling, nutrient mineralisation (soil fertility)
- degradation of pollutants (important for e.g. clean ground water)
- biological control of agricultural and forestry pests
- structure formation of the soil (important for water holding capacity of the soil, role in prevention of desertification, erosion, floods and the effect of droughts)
- fixation of CO_2 (soil as a carbon sink)
- production of soil organic matter (important for soil fertility and also in prevention of erosion and desertification)

III The status of SOM in Europe (Due to the lack of data, the status of soil biodiversity cannot be treated)

Data on the status of soil are limited. This limitation prevents the development of a clear view of the status of SOM in soils at the European scale. At present the most homogeneous and comprehensive data set on the organic carbon content of European soils can be extracted and /or derived from the European soil database (using pedo transfer rules) complemented by associated databases on land cover, climate and topography. A map of topsoil OC in Europe has been constructed and published (S.P.I.04.72) and is available for supporting the policy process in the context of soil protection. This will be improved over the coming months by comparison with national data sets and data obtained from other sources, such as the FOREGS survey and the study on organic matter contents of European soils commissioned by JRC. Fortunately, a few good quality national maps exist, providing the basis for a general view of the repartition factors of SOM in Europe.

Natural factors (climate, soil parent material, land cover and / or vegetation and topography) explain a general contrast between north and south (or with elevation) and these factors provide 'hot spots' with very high contents of C in the sub boreal and alpine soils, peats and other organic soils. The dominant effects of low temperature, and / or high moisture content explain this C accumulation. Such soils need a specific strategy of protection and management.

Factors related to human activity (land use, management and degradation associated with cultivation) explain the widespread low C values of many arable lands (loss of 20 to 50 % C compared with natural soils).

A combination of environmental and human factors account for the relatively low SOM values of the soils in the Mediterranean area, with 74 % of the soils having less than 2% C (3,4 % SOM), which is often considered as a threshold value for erosion and desertification.

Forest and grassland soils have relatively high contents of C, but the trends in the extent of areas of forest and grazing are in sharp contrast. The area of forested land is showing signs of increasing, that of grazing land appears to have decreased substantially. It may require positive action to prevent further reductions with associated declines in SOM.

Recommendations concerning the status of SOM

The status of SOM is known locally in many European countries but harmonisation of these data is urgently needed. Currently there is only the topsoil OC map of Europe to provide a summary of the status for the continent as a whole upon which to make policy decisions.

- **Recommendation 1**: those Member states with adequate national data sets on OC or OM should release / make available national records for validating the European OC map (as already done by UK, Finland and Italy).
- **Recommendation 2**: those Member states without adequate national soil data sets on OC or OM should implement sampling programmes to define the existing status.

The organic matter status depends on soil type, climate, land use and human activities.

- **Recommendation 3**: the land use patterns in areas where the OC Map of Europe identifies soil OC (OM) <2.0% (<3.4%) should be critically examined with a view to making changes to agricultural and other land management practices to stabilise or increase soil OC levels
- **Recommendation 4**: the relationship between soil sealing and soil organic matter should be carefully examined, using terrestrial databases and remote sensing for example, with the aim, where economically possible, of protecting soils with relatively high organic matter levels from further urban and industrial development.

Monitoring organic matter

- **Recommendation 5**: Organic carbon/organic matter should be measured in the soils of Member States ideally by sampling on a 15km or 16km grid (or an equivalent spatial density), followed periodically (approximately every 10years) by a resampling of a statistically significant subset of points (e.g. 10%) on the original inventory grid or sites.

IV Policies available to improve soil organic matter status

The Task Group has focused on the establishment of a framework to address the various links existing between soil organic matter and land management policies (in accordance with the DPSIR approach). The expected outcome of this framework is to provide guidance and action oriented recommendations in the perspective of the establishment of an EU Soil thematic strategy.

The various links existing between soil organic matter and policies can be addressed from different points of view such as:

Policy themes

- 13 policy themes are considered to influence directly or indirectly SOM. The targets of these policies are different and in some cases they could be – with respect to SOM – contradictory. In this regard, the DPSIR approach can help. By considering the current state (S1) and the expected state (S2) of SOM contents and quality, it is easier to propose a framework policy response, encompassing these policy themes.

Policy tools that influence directly or indirectly soil organic matter

- Referring to an OECD study in agriculture, 18 policy tools or "sub-tools" are identified. Some of them are broadly used in the EU, others appear to be rarely found in agriculture in the EU. Finally, tools such as cross-compliance mechanisms are given increasing importance in the context of the EU political evolutions (particularly the CAP reform). Within the framework of an EU soil thematic strategy, policy responses addressing SOM should make use of various policy tools in a coherent way. This task group proposes an example of coherent way of proceeding (Task Group 5)

Geographical approach

- 5 geographical scales are considered as politically relevant for the management of SOM. It is noted that the sub-national, or even the local level could probably be the most appropriate scale for policy implementation. However, this does not prevent such low scale policies to be integrated in larger scale frameworks.

Historical approach

- In the relatively recent past a number of policies and related actions have resulted in negative changes in SOM. CAP reforms, agri-environmental programmes and environmental policies are attempts to overcome the environmental (and SOM) damages caused by the agricultural policies and practices of the years 60-80. The effects of these new policies are unlikely to be visible in the short term.

Qualitative approach

- It is recalled that the process of cultivation (and more generally any anthropogenic land use) of native soils is nearly always associated with a loss of organic carbon. But this inevitable loss of organic matter needs not necessarily lead to a permanent loss of function. An equilibrium between inputs and outputs can be achieved at a lower level of productivity, which may lead to sustainable soil management, although there are changes in land use and the social and economic dimensions of sustainable agriculture are respected.It is also recalled that the purpose of these practices is not necessarily to obtain high SOM contents, but rather sustainable contents that contribute to essential soil functions such as prevention of erosion, water storage, greenhouse gases sink and nutrient supply.

Recommendations concerning policies

The task group also assessed the (expected) effects of the listed policy themes and policy tools on SOM quantity / quality, as well as the scale of these effects. At this stage, the main conclusions and recommendations of this assessment exercise are:

1. Whereas SOM losses are not only due to practices, but also to other reasons such as climate, one of the basic principles of the EU Soil Thematic Strategy should recognise that it is necessary to avoid SOM

losses by promoting appropriate (agricultural) practices and preventing potentially harmful (agricultural) practices.

2. Among these adequate (agricultural) practices, maintenance and management of grasslands (herbaceous land), crop residues management, cover-crops, manure land-spreading management, crop rotation management, use of compost, sewage sludge and soil improvers and cultivation management are often recognized as key issues (see conclusions of Task Group 4 and 5). Concerning potentially harmful (agricultural) practices, it can be noted as an example, that the burning of crop residues has a strong negative effect on SOM, but such practices are still prevalent in some parts of Europe.

3. An effective EU Soil Thematic Strategy should recognise that soils are a substratum permitting the development of various and sometimes contradictory vital processes such as vegetal growth, food production, carbon sequestration, water retention and filtration and human activities. Concerning SOM, the objective should not be to maximise contents but rather to optimise contents in order to allow the above-mentioned functions to operate effectively. Where problems may arise and depending on the individual situation, a less ambitious objective of steady state can represent a first necessary *step (location specific quality criteria)*.

4. It should be kept in mind that, in agriculture and in forestry, a large part of the potential pool of organic matter for soils does not leave the parcel (or at least the farm). This pool of organic matter (direct pool) is made of roots, crop residues, agricultural wastes (manure spread to land) and the existing SOM itself. Management of this direct pool is the easiest and the cheapest way to implement strategies to maintain or improve SOM (adequate agricultural and forestry practices). Therefore, it is proposed that the EU Soil Thematic Strategy consider this direct pool as a priority.

5. Whereas most of the existing policies mention the respect of the environment and indirectly or directly the respect of soils, such mentions are not always precise, and SOM itself is rarely specifically mentioned. The development of an EU Soil Thematic Strategy should help to more clearly specify the references in the existing legal texts. Therefore, it is recommended to provide recommendations about SOM management (promote good practices and banish harmful practices appropriate to the environmental context) in order to adapt, modify or make more precise existing policy instruments.

6. Under the “mid-term CAP review”, the effect on SOM of the “decoupling” scheme for financing of the farmers remains unpredictable. It is therefore of key importance to monitor and assess this process.

7. Under the “mid-term CAP review”, the set-aside requirements as well as the obligation to maintain permanent pastures are key issues in the scope of SOM management. It is well known that grasslands (herbaceous land) have, in general terms and in comparison to arable land, a high potentially positive effect on SOM, vulnerability to erosion and soil quality in general. The duration of the land use as grassland is however an important consideration as short duration grassland may lose the beneficial effects associated with grassland establishment. Of course this aspect has to be seen from the perspective of a local, regional and national food supply as well as of a well balanced landscape management. Therefore it would be not wise to increase the grassland area based on a one-sided arbitrary SOM argument.

8. The “good agricultural conditions”, recently introduced into the “mid-term CAP-review as cross-compliance requirements, specifically refer to soil erosion, soil structure, and soil organic matter. These “good agricultural conditions” represent therefore a major driving force influencing SOM contents in the EU, but in order to be efficient, these “good agricultural conditions” need to be better defined. Obviously coherence necessarily needs to be established between this concept and the concept of “good farming practices under council regulation (EC) 1257/99.

9. Organic farming (Council regulation (EEC) 2092/91) and agri-environmental measures (Council regulation (EC) 1257/99) are potentially powerful existing instruments that can contribute to meet aspects of the EU Soil Thematic Strategy objectives. Whilst the widespread adoption of organic farming is unlikely, aspects of the practices undertaken in organic farming should be considered for incorporation in more conventional farming as part of an integrated farm management approach.

10. The Nitrate Directive (91/676/EEC) is one of the rare listed policy instruments, which tends to hinder SOM contents raise. A revision of the Nitrate Directive is recommended.

11. Among the most recent policy instruments developing inside the EU, some tend to maximise SOM contents (carbon sequestration). In this regard, the EU Soil Thematic Strategy should tend to mitigate the potential negative effects of possible surplus and promote the site and management specific optimisation rather than maximisation.

12. Concerning the use of renewable energy sources, it should be recalled that any combustion of organic matter (biomass) necessarily impairs possibilities of incorporation of the residues into the stable pool of organic matter in soils. The EU Soil Thematic Strategy should therefore tend to mitigate the potential negative effects of such drawbacks, in particular when using biomass that was not harvested for energy purpose.

13. Principles for sustainable forest management are not (or few) incorporated into legally binding EU instruments. In the future, such principles could be developed and considered as ‘good forestry practices’.

14. Care should be taken to prevent SOM being negatively affected by non-political driving forces, such as market, economical, social or environmental evolutions.

15. Compliance with aspects of the Kyoto Protocol on carbon cycling and sequestration is likely to be a major influence on SOM dynamics.

16. Current directives such as the Water Framework Directive need to be reviewed afresh and the possible impacts on SOM considered.

17. International Convention or national legislations on biodiversity are very general and they have to take more into account the below ground biodiversity.

18. If protection policies exist for wet lands or peat lands, an extension is certainly necessary for what we call hot spot for carbon.

V The best practices for agriculture and forestry for SOM management -considerations and recommendations

In a general way, even if data are missing, good management of SOM will coincide with good management of soil biodiversity

Cultivation in general results in a serious decrease in SOM as compared to the natural vegetation, and efforts should be aimed at

1) preserving SOM where it is still available, as it is more difficult to replenish lost SOM than to conserve it, when it is still present in the soil, and
2) at increasing SOM content in SOM depleted soils.

"C hotspot soils" **(soils with high C content)** should be given high priority to preserve their SOC stocks. These "C hotspot soils" include peat soils and natural wetlands, alpine soils, forests, natural grasslands. Especially peat soils cannot be managed for agriculture without large losses of SOM and should therefore preferably be “hydro-ameliorated” allowing for natural vegetation to develop.

Because of the overall positive feedback of SOM-improving measures with biodiversity, and the maintenance/improvement of soil function, the following practices shall be especially **recommended**:

1. a generalized use of catch crops/green manures: apart from increasing SOM contents, this practice reduces nutrient losses and improves soil structure. The use of green manures may be limited by available water (one should avoid competition for water between the green manure and the main crop). However, the improvement of soil structure, also in deeper layers, and increased SOM content may result in a more efficient water retention and uptake of water that would otherwise not be available to the crop. Such strategies are responses to protect soil surfaces vulnerable to erosion and to reduce nitrogen losses by leaching in Nitrate Vulnerable Zones. Evidence from France suggests this in an increasingly widespread strategy

2. the creation of buffer strips along the borders of agricultural fields serves not only as a carbon reservoir but reduces at the same time soil erosion, the discharge of agrochemicals (pesticides, nutrients) to waterways and increases biodiversity (ecological function)

3. maximization of the use of crop residues as high quality unpolluted sources of both nutrients and soil organic matter. For some residues, such as residues from sugar beet or vegetable crops, the timing of incorporation may be important in order to avoid risks of nitrate leaching

4. conservation tillage, well developed in several countries outside Europe causes a relatively small increase in SOM, but at the same time may strongly reduce soil erosion by water, improve soil physical properties, increase soil biodiversity and improve energy efficiency of agriculture. Conservation tillage is best suited for areas with continuous grain crop rotations. Notably the presence of crops such as potatoes, sugar beet, chicory, etc., is not compatible with no-tillage.

Conservation tillage should still allow for application of organic matter to the soil without large losses of nitrogen, and appropriate methods have to be found to make this possible. Possible drawbacks such as increased herbicide use or N_20 emission should be taken into consideration, and more multidisciplinary research under European conditions is needed.

- application of exogenous organic matter coming either directly from farming activities (farmyard manure, animal slurries) or indirectly as by-products from agro-industries and consumption of agricultural products (sewage sludge, compost). For a safe application of these exogenous organic materials, strict quality control is of utmost importance and a long-term sustainable application of these wastes will only be possible through the implementation of measures that reduce pollutants in these organic materials. This includes, for example, the reduction of heavy metals and antibiotics in animal manures and slurries (through changes in animal feeding), the reduction of pollutants from industrial effluents and in general a strict source separation of materials. The separate collection of the biodegradable fraction of household waste can achieve great results, as it is shown today in Germany where biowaste compost has comparable standards to green waste compost.

Agricultural systems are made up of a set of land use practices, and these systems will differ in their ability to conserve or build-up SOM, depending on the land use practices that they consist of. There is evidence that the set of agricultural land use practices that are broadly known as the ‘organic farming system’ is in particular more able to build-up organic matter in soil as compared to, for example, conventional farming.

Some of the proposed measures may have profound impacts on the economy of farms. Compensation may be needed to realise these changes (e.g. generalised use of buffer strips, taking peat soils out of production).

Forests are managed ecosystems coming close to the natural situation. Forests thus fulfil important retrieval / habitat and preservation functions for flora and especially fauna. In forestry, modern ecological silviculture already took up many positive ecological impacts, including the likely regain of soil organic matter of these soils which had historically suffered from land use change or heavy secondary overuse. The trend in human-induced acidification of the 70s until the 90s, which affected most of central and northern European forests, has caused thick forest floors that represent a risk of nutrient losses from pulses of mineralisation after harvesting and in response to climate change. Today the atmospheric input of nitrogen

represents a new potential risk towards the depletion of humus and thus nutrient reservoirs in biologically available humus fraction. In general, clear felling should be avoided wherever possible, and regeneration methods that use mechanical soil preparation, the removal of forest floor including ground vegetation, should be conducted in as sensitive a manner as possible.

Soil monitoring is needed in order to assess the effects of land use change, as well as changes at the level of management types. The range of methods, indicators, and representative criteria required for such a monitoring processes reaches across various spatial and temporal scales. Attention must also be paid to reduce the immense gap between large-scale inventories and biogeochemical as well as coupled ecological-economical sector models. Consequently, a sophisticated concept will be needed that allows for several levels of measurement intensity, in combination with a system of management-related reference sites, where long-term observations are possible, and where sampling quality is high enough to minimize the uncertainties otherwise typical for large scale inventories.

VI The place of exogenous organic matter in soil organic management

Definition, sources and production of EOM

Exogenous Organic Matter (EOM) is considered as all organic matter that is returned to the soil for the purpose of growing crops, improving soil quality and in restoring or reclaiming land for future use. In this report a direct pool (treated with the agricultural practices) and an indirect pool are considered**.** EOM includes a very wide range of biowastes (or biodegradable wastes) from a considerable variety of sources. In this report, the term EOM does not include organic matter that is already present in the soil.

EOM is 'exogenous' to soil in that it comes from external sources such as urban areas, municipalities, agriculture, forestry and industry sources. Enormous quantities of EOM are produced within the EU. Current estimates are that in excess of 1.6 billion tonnes are produced in the EU each year, of which 61% is animal wastes, 25% crop residues, 7% industrial wastes and 7% urban and municipal wastes (sewage sludge, biowastes and greenwastes). It is estimated that sewage sludge represents approximately 1%, industrial wastes 2% and animal manure and slurries 97% in terms of mass of material spread currently on land.

The amount of EOM that will continue to be used in future to protect or improve soils largely depends on its quality and the confidence of farmers, retailers and the public. However, landspreading is expected to increase following the introduction of EU-wide and national regulations, which divert organic-rich materials from landfill. Furthermore, the amount of sewage sludge is projected to increase due to the progressive implementation of the Urban Waste Water Treatment Directive 91/271/EEC. Food processing and paper sludge are also potentially very significant organic waste streams.

Use of EOM

EOM and their derived materials can provide a wide variety of products for a wide variety of markets. They can improve and condition soils, supply nutrients, be used to manufacture substitutes for soil, act as top dressing or mulching material and provide multi-purpose growing media for horticulture, etc. The final destinations may be agriculture, horticulture, landscaping, professional gardening, private gardening, etc.

The fundamental question is how to derive most benefit from EOM within the EU such that soils are protected and used sustainably. EOM is viewed in this report both as a way to afford soils protection and potentially as a way to improve their quality (when applied under strict quality assurance).

Recommendations concerning use of EOM for soil improvement and other environmental benefit

Task Group 4 concludes that EOM-use should be viewed as a positive activity that is to be recommended in production systems where good practices, soil and EOM quality issues are fully observed and accounted for.

The authors of this report acknowledge the potential of other soil, crop and livestock and biowaste management techniques to maintain or increase soil organic matter and that EOM use needs to compliment these to confer benefit to the soil. An important consideration is that farmers and their advisers will need to be equipped with information on the types of EOM that are available to them and the way in which these materials can be used for wider benefit.

1. The application of EOM on soil is in principle recommended if it is of an appropriate quality and if it is applied according to good practices.

2. If these two requisites are fulfilled, the application of EOM is recommended because it can *limit the decline of soil organic matter* and assist with *reducing soil erosion* particularly in areas where degradation of soil is an issue. It can assist in the maintenance of minimum site-specific SOM levels and in sustaining different soil functions. It can supply stable and non-stable organic matter to soils in support of important soil functions.

3. Contrary to mineral fertiliser which does not contain organic matter, the application of EOM can also *enhance biological activity* in soil, which induces *better aggregation and/or better porosity of soils*.

4. Compost from separate collected biowaste fraction from municipal waste should be recommended in order to improve biological/physical and chemical soil functions and the application of nutrients in a valuable form.

5. The application of limed sewage sludge should be recommended as mineral amendment to correct soil pH.

6. The application of EOM can thus *improve tilth and workability*, *increase buffer capacity*, *may reduce nutrient leaching*, *improves water retention*, etc. of treated soil.

7. All of which impinge upon *savings of energy*, *savings of non renewable resources* (such as mineral phosphates), *protection of organic soils* from peat extraction (as compost can be added to soil improvers and growing media, partially replacing peat) and sustainable management of croplands.

8. The application of EOM is also recommended because it can *close nutrient cycles*, contribute to *reduced nutrient leaching* and *less reliance on non-renewable materials such as mineral phosphates. EOM contains nutrients (mainly nitrogen and phosphorus*) in different forms, quantities and availability according to the type of EOM.

9. Applying composted EOM to soils should be recommended because it is an effective way to divert carbon dioxide from the atmosphere and convert it to organic carbon in soils, contributing to *combating greenhouse gas effect*.

10. The application of limed sewage sludge could be recommended as mineral amendment to correct soil pH, where necessary.

11. Composting or anaerobic digestion of animal manure and slurry together with straw, green wastes or other EOM, in vulnerable areas, could also be useful to move the excess of nutrients from surplus nitrogen areas to deficient areas. Through composting or anaerobic digestion a stabilised organic amendment, whose weight is reduced (to 1/5 – 1/4 of the raw materials prior composting), is obtained, which makes storage possible and transport easier.

Recommendations for ensuring good quality of EOM for soil protection and for policy

The quality of the EOM is of paramount importance when recommending its application to soil. The authors of this report recommend the development of a consistent approach for the safeguarding of long-term sustainable application of any type of EOM on land.

1. In the short term Soil Protection Strategy should support the recycling of clean EOM on soils, and support the initiatives, in the frame of EU waste legislation of *revision of the Sewage Sludge Directive and a Biowaste Directive* along the lines already discussed in previous Working Documents.
2. In the medium term, this directive should also include the *legal framework for slurry and manure* to control the spreading of these EOM on land and prevent long-term soil contamination.
3. This means that the *concepts used to choose priority contaminants and to derive limit values for contaminants must be the same for all EOM*, and more generally for all fertiliser and amendments (for organic fertilisers and amendments, as well as mineral ones such as phosphate).
4. In order to prevent soil contamination (by heavy metals and organic compounds), several source prevention actions are recommended (e.g. separate collection of biowaste, separate roadways streaming / storm overflow from urban waste water in the sewerage systems, a sewerage systems police/regulatory force, separate collection of toxic wastes from householders and manufacturing sites, reducing quantities of Cu and Zn added to the diet of cattle and pigs and improving their bioavailability and assimilation).
5. In order to prevent soil contamination from a part of organic compounds and to prevent pathogens dissemination, appropriate treatments must be promoted to sanitise EOM before use.

Recommendations for proper / good practices

The authors of this report recommend the application of EOM on soils if it is carried out according to good practice.

1. This means that the application of EOM to the soil takes into account the needs of the soil, the soil use and the climatic conditions. This should include, for the EOM, *the nutrient supply* (e.g. nitrogen, phosphorus and potassium), *organic matter characteristics* (i.e. stable and non-stable OM) *and the potential impact of contaminants* (such as heavy metals and organic compounds). It is important to have a proper fertilisation plan at the farm level and to take into account all the fertilisers inputs (i.e. inorganic fertiliser and EOM input of nutrients). This latter point is of great importance in vulnerable areas with high concentration of breeding animals, where nitrate pollution of water courses and eutrophication of surface waters are problematic (Nitrate Directive).
2. In order to achieve the previous recommendation, better characterisation of the nutrients and organic matter kinetics, it is also recommended to provide good tools to inform agronomists giving advice to farmers. This means that it is necessary to have normalised tests, “simple” models and references data bases to be able to give good advice to farmers (or other users), to be able to produce a proper fertilisation plan, to avoid nutrients losses, such as N and to adapt the type of OM from supplied by the EOM to the soil function which is to be improved. In order to be able to use models, software should be promoted. Several methods exist to characterise the form of OM in the EOM: (i) methods which determine a labile fraction (carbohydrates, proteins, cellulose polysaccharides) an intermediate fraction (non-cellulose polysaccharides, proteins) and a stable fraction (lignin, creatin), (ii) soluble C, (iii) respirometry incubation test, etc. Characterisation of the organic matter forms in EOM is a very important consideration so that the timescale over which benefits are delivered can be better understood. This is an area where novel techniques are being developed and where there is potential for harmonisation of approaches across the EU.
3. It also means that the application of EOM must be done within clear guidelines and restrictions depending on the properties of organic fertilizers/soil improver (i.e. restriction on timing of application, for example not on frozen ground, not within a certain distance from the water course, not on natural forests, no grazing period immediately after application, injection of untreated EOM, etc.) and that *quality assurance scheme / certification scheme for collection, treatment and landspreading* must be promoted.
4. An *advisory service to farmers or other users* (landscape gardener, etc.) must be promoted. This should include agronomic advice and also advice concerning possible pollutants and hazardous substances

VII The impacts of the decline in soil organic matter and the benefits of the recommendations

Historical data and also scenarios of prospective changes in the future are needed to quantify the impacts of the decline in soil organic matter and the benefits of the recommendations .

The land use in Europe is dominated by agriculture (40 % with 24 % of arable land and 16 % of grassland) which is a major economic activity and forests (42 % with an increasing trend). Globally the quantitative land resource is sufficient but there is an increase in anthropogenic use which is of particular concern on soils of good quality.

At present we have only historical data on uses of soil in agriculture and, partly, in forestry, across Europe since 1960, and the impacts of human activities on SOM. Such activities can mostly be linked with a decrease in SOM (link to cultivation) with consequent impacts on biodiversity, soil and environmental quality, and in some areas direct effects on erosion.

The current revisions of CAP offer a real chance to improve the relationships between agriculture and environment and to change negative externalities of agriculture to positive ones (water and air quality, quality of the landscape). The CAP reforms and the Natura 2000 framework should take into account all agricultural contributions to the environment.

To be effective the policies on good practices have to be discussed with the actors, who are the farmers. Such reforms should be acceptable because they allow the maintenance or restoration of good soil quality, representing an ecological, cultural but also economic benefit**.**

The use of EOM**,** which may be a sustainable solution of soil organic matter loss, has also to be agreed on and discussed with the farmers and consumers of agricultural products in order to prevent any risk of negative effects. The implementation of the Kyoto Protocol for forestry and land use also represents a possible new incentive tool in order to fulfil the sustainable management of SOM; it offers the opportunity for agriculture to contribute to prevention of climate change. Many of the land management measures or practices which are included in the CAP reform should encourage the sequestration of carbon, and the surface area involved will be millions of ha.

We have to stress also the importance of the **UN Convention on Biodiversity** and its importance in relation to sustainable agriculture**.**

In conclusion the over-riding recommendation from the Working Group will be to manage soil organic matter for its multiple functions which fit within multiple policy (and benefit) objectives: this is particularly true for win-win solutions which increase organic matter and biodiversity and prevent erosion or desertification; this can represent the best tool for the European strategy on soil protection.

VIII Recommendations for monitoring and research

Gaps and needs of research are numerous in the domain of SOM and soil biodiversity .

The priority will go to the functions performed by OM and organisms and how we can manage the consequences for the soil. Practical aspects are necessary like carbon capacity to retain C and under which form, specific quality criteria are necessary for exogenous MO in relation with benefits; new bioindicators and the knowledge of ecological benefits (including economy).

SOM levels and the nature and quality of SOM determine different soil functions. Whilst this subject area has been the subject of considerable research over many decades, there are still gaps in our detailed knowledge and understanding of the nature, properties and ecological significance of the overall levels of SOM and the different pools. There is a need to more specifically understand the relationships between SOM levels and quality, and soil function, soil properties and behaviour, land use and land management, climatic fluctuations over different time scales, etc.

With respect to the relationships between SOM levels and quality and the nature and function of soil biodiversity there are still many gaps in our knowledge. Whilst it is widely acknowledged that maintenance and improvement of biodiversity is in itself an important target of current policies and conventions, it is important to establish the roles of a diverse community of organisms within the soil. There is a need to establish the nature of the relationships present under a range of conditions and how these relationships vary across the complex natural and managed environmental conditions across Europe. It is also important to establish what are the natural variations in these relationships and how robust the relationships are under scenarios of changing climate and environment.

A Research

Cluster 1 – Analysis of Threats

We need to more fully understand the role of SOM in optimising soil functions.

To understand the importance of changes in SOM the following has to be investigated:

- The role and turnover dynamics of the fractions of SOM
- The role of dynamics of soil organisms at sub-molecular and physiological levels.
- The nature of the relationships between SOM fractions and soil organisms.
- The value of soil organisms/soil ecological capital

Furthermore research has to be done on:

- development of methods to extrapolate information obtained from the sample through to the field, regional and global scales.
- characterisation of soil biodiversity at selected key natural and managed ecosystems, and ecosystems currently undergoing change in natural and anthropogenic processes.
- Relationships between SOM and soil biodiversity
- Management of SOM and soil biodiversity

At present knowledge of soil biodiversity threats is mainly qualitative. The results of the research should provide possibilities to quantify the threats. This implies research on the ecological, economic and social valuation of soil biodiversity, and the effects of human activities and on composition and activities of soil ecosystems.

Much of the questions may be investigated by setting-up of “EU coordinated” long term controlled field experiments (such as Rothamsted) in different places in Europe.

In the past much of the emphasis has been focused on SOM in mineral soils. Carbon ‘hot spots’ (e.g. peat soils)

should be given equal emphasis. In particular the rate of decline of organic matter under a management of agricultural production and forestry must be investigated. Similarly the consequences (and the reversibility thereof) of removing agricultural or forestry practices on these soil must be understood.

Cluster 2 – Development and harmonisation of monitoring and characterisation methods

- Development and harmonisation of standardised methods for characterisation of the nature and function of the SOM pools from a biological and structural perspective in contrasting environments across Europe.
- Development and harmonisation of appropriate standardised methods to characterise biodiversity of soil organisms.
- The selection of organisms to be monitored in monitoring programmes should be based on:
  - ease of measurement;
  - value as an indicator;
  - relationships with other organisms;
  - relationship with soil function.
- There is a need to provide a scientific basis for a minimum data set appropriate for this purpose across the contrasting natural and managed ecosystems in Europe. These methods will probably be at a range of scales from whole organisms and communities through to characterisation at the genetic (DNA, mRNA) and at the protein level.
- To facilitate reproducibility of sampling and to enable comparison of monitoring data standardised sampling techniques must be developed and adopted.
- To facilitate comparison of monitoring data, fast and preferentially automated characterisation and identification techniques of soil organisms must be developed and adopted.
- For standardisation of the above mentioned techniques activities of ISO should be stimulated.
- Development of techniques to extrapolate the results of monitoring activiteis of SOM and soil biodiversity to the appropriate spatial and temporal scales.

Cluster 3 – Driving Forces and Pressures

This Cluster comprises research on:

- Effects of climate change and associated land use changes on SOM levels and pools and biodiversity.
- Effects of management practices in farming and other land uses (e.g. additions of EOM to soil; changes in tillage practices; conventional-v-integrated-v-organic farming; incorporation of residues from GM crops; restoration of damaged land) on SOM levels and pools and biodiversity. Optimisation of SOM and soil biodiversity by application of (combinations of) management techniques
- Contributions of different agricultural crops and plant covers on SOM levels and pools and soil biodiversity.
- The effects of contaminants on the role and function of the SOM pools and soil biodiversity.
- Characterisation of the potential of soils to sequester carbon under different environmental conditions. Assessment of the broad principles, which can be provided across Europe and within specific climate:landscape combinations.
- Establishment of the requirements for development of models to assess effects of land-use on SOM and soil biodiversity for policy and guidance frameworks.

Cluster 4 – Analysing impacts

- Analysis of the role of the SOM pools in determining soil functions.
- Analysis of the relationships between the structural and functional properties of soil biodiversity and soil functioning. It is of particular the 'tolerances' of these relationships, the resilience to change in soil functioning and the extent and rate of recovery. This is also true for the SOM pools.

Cluster 5 – Responses

- Investigation and evaluation of the effects (positive and negative) on SOM pools and functions of different levels of tillage across a range of environmental conditions.
- Investigation and evaluation of the effects (positive and negative) of the incorporation of a range of exogenous organic materials on SOM pools and functions and soil biodiversity.
- Investigation of the possibilities to influence the resilience of SOM levels and pools and soil biodiversity to changing environmental conditions
- Development of indicators to facilitate management of soil biodiversity on local level (e.g. for farmers and regional nature development), on the national level (e.g. spatial planning) and on an international scale (e.g. evaluation of the success of international treaties).
- Development of an evaluation system for soil quality to enhance the interpretation of indicator values (good or bad quality, desired or undesired quality, suitable or not suitable for a particular soil use).
- Development of statistical techniques and models for the assessment of trends in space and time.

B Monitoring

Aspects of SOM monitoring will form part of the basic parameters (total C and N and density for stock calculations) in most soil monitoring schemes. However, the Working Group recommends characterization of the quality of SOM with the determination of C pools which are necessary to evaluate the impacts of agricultural practice and for the determination of thresholds values.

The Working Group recommends **the monitoring of biodiversity,** applying precise indications on what (diversity, abundance, and activity of the organisms and functions) and how to measure. ISO methods are available on the determination of microbial biomass (which is one of

the pools), presence and main composition of microorganisms (fungi and bacteria) and soil fauna. Using two indicator organism groups (e.g. nematodes and earthworms) general trends in soil biodiversity in relation with soil quality and land management can be assessed.

The group is open to a general discussion in order to precise both the sites, the content of different monitoring levels, and the monitoring conditions.

Several documents on monitoring are available. The proposals of the group follow the following lines:-

If clear relationships between SOM, soil biodiversity and soil functions are to be established, it is necessary to go further than the classical determinations of C/N which are normally made.

At least two sets of determinations are necessary:

1. The determination of carbon pools. On this subject there is a consensus for a size and density fractionation which can be complemented by structural characterizations easily available in routine analysis.
2. The monitoring of soil biodiversity (and biological functioning). This is more complex to realize, but a choice of methods is already available.

Methods for sampling and characterisation of fauna, (e.g. earthworms, nematodes enchytraeids, mites) are already operational.

Determination methods for microflora are classical in many laboratories (e.g. biomass, respiration, C and N mineralization).

In order make progress, a step by step method can be used. Differentiation of fungi and bacteria is now available by using different methods. Complementary approaches using DNA chips are still in development, but offer considerable future potential. To enhance the interpretation of indicator values (good or bad quality, desired or undesired quality, suitable or not suitable for a particular use of soil), an evaluation system for soil quality has to be derived in conjunction with the indicators The extrapolation of monitoring data and indicator values will be made by using statistical techniques and models to enhance the assessment of trends in space and time

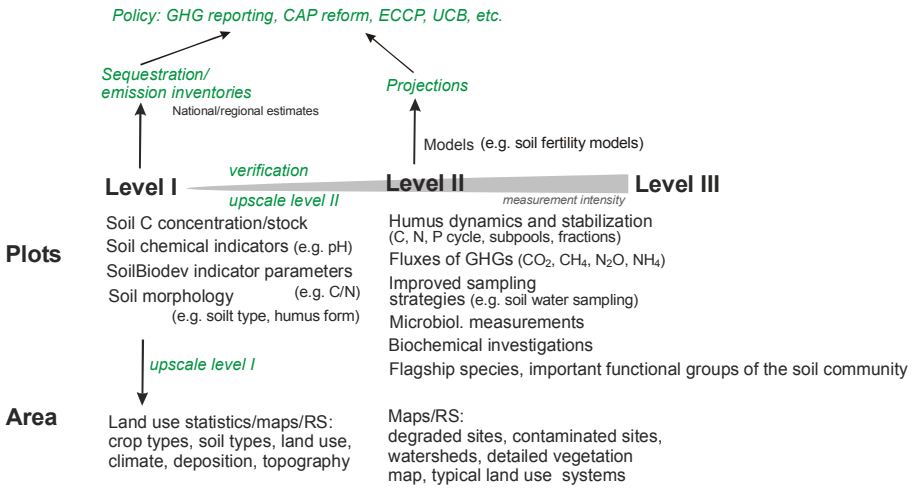
For all the methods cited data are missing in the necessary range of conditions of soil, climate, land use and agricultural practices. Monitoring is needed to obtain these data and to draw indicators for soil quality and good management practices.

On a local, regional and national scale, many data are collected already, mostly for research purposes. These data must be made available for other users. (International) Databases must be built to facilitate data exchange.

Problems to be solved by the monitoring group are more a question of the structure of the monitoring networks.

If the number of monitoring sites is not too high, most of the proposed determinations can be made; another solution is to make the determinations on a selection of sites which differ by the soil conditions described above.

In the documents of the group, a monitoring structure is proposed a structure with different levels. This structure very similar to the forest monitoring network:



A level 1 with a geographical grid of geo-referenced sites in order to monitor the status of SOM and the change in status with time (minimum 5 or 10 years). The knowledge of this status is currently not good enough at the European scale. These data are necessary (with good models) for Kyoto protocol verification.

A level 2 which would be thematic, different for forest, agriculture, waste recycling, or sites of specific interest (high content of SOM, erosion or desertification hot spots, cultural heritage).

For the level 2 of forest monitoring the proposition will include biodiversity and better characterization of the humus layer.

level 3 which corresponds more to research sites even if research programs can be developed on level 2.

The level 2 can probably be common with the contamination group in the case of waste recycling or good agricultural practices; for good agricultural practices, sites can be established at a watershed/catchment scale and be common with the erosion group.

Reminders of the main considerations involved with monitoring

Soil is a living multifunctional medium and a Europe wide monitoring system must be developed to address both the questions of politicians on the status and trends in soil organic matter and soil biodiversity, and those of other soil users on the functioning and potential uses of the soil.

The considerations on the monitoring of soil organic matter and biodiversity must take in to consideration both the need to address and comply with international Conventions and Europe-wide policy requirements.

With particular reference to International Conventions, there is an opportunity for the soil monitoring network to be a reference base for the Kyoto Protocol (gain of OM) and the convention on climatic change (loss of OM).

There is also the possibility of the development of a significant contribution on soil biodiversity within the context of the Convention on Biodiversity.

To ensure good progress cooperation should be established with the projects of OECD on biodiversity and agri-diversity indicators.

Concerning EU Directives, a detailed monitoring system is necessary to furnish indicators to the Common Agriculture Policy on the good ecological practices and to assist managers to apply the Framework Directive on Water and the Nitrates Directive.

In conclusion the Working Group reiterates the importance of soil organic matter and soil biodiversity in maintaining many of the functions of soil. The soil functions are essential to the operation of natural, semi-natural and man-managed systems and if development is to be sustainable these functions must be maintained. Moves towards a Directive for Soil Protection and Sustainable Soil Use are essential if these functions are to be protected. Such a Directive should encompass directives on the management of Exogenous Materials (Sewage Sludge and Biowaste) as soil amendments, although given the importance of these potential organic matter additions to soil interim measures should be considered to avoid further delays in their beneficial us.

CONTAMINATION

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General Introduction

Contamination is one of the main threats to soil identified in the EU soil communication (COM(2002) 179 final). Prevention of soil contamination has strong links with policies on chemical substances and with environmental protection policies for water and air. It has also strong links with policies concerning certain land uses, for instance agriculture.

The relation between soil contamination and waste management is obvious as well. Bad waste management has led to a large number of contaminated sites. Better waste management has led to recycling of waste as construction products, or as composts and sludges that can be used as fertilisers. Both ways of recycling may positively or negatively affect the quality of the soil. Waste disposal by landfilling is now subject to environmental regulations which protect soil and groundwater.

In fact many policies have significantly contributed to the protection of soil. However soils are still subject to many pressures leading to soil degradation, which calls for a policy which addresses soil in it's own right. Such a policy should not replace current regulations which already contribute to soil protection but act as an umbrella. It may be described in a policy document aiming at the coordination of the implementation of regulations already in place and at improving current regulations if soil is not addressed sufficiently. The legal basis for such a strategy document is implicit in EU treaties and the proposed directive on environmental liability (COM(2002) 17 final). There is also political commitment from the European council (CO-DBP (2003) 10) and European parliament (2002/2172(COS)).

The discussions in the TWG contamination have strengthened the above point of view. Specific policy strategies have been designed for local sources of contamination, for agricultural soil uses, for management of contaminated land and for large scale diffuse pollution. The strategies, which form the basis of the policy recommendations of the working group, are tightly linked to the way the land is used and identifies the owner/user of the land as the primarily responsible party for soil protection. For agricultural land the farmer has to treat the soil in a balanced way in order to save the soil quality for future generations. This should be supported by production of high quality products and proper information on usage. For land of local sources the owner has to prevent soil contamination by safeguarding avoidance of release of substances to soil as much as possible. For contaminated land the owner of the land is responsible for managing and improving the situation only if the polluter cannot be legally addressed. A policy approach for large-scale diffuse pollution however requires large-scale integration of soil protection, air and water policies and land use policies. The water framework directive provides opportunities for management of water quality and quantity at the river basin scale and will become an important vehicle for soil and sediment protection and further integration of environmental management. The abatement of large-scale diffuse contamination problems will for long be the task of public authorities and EU wide coordination is necessary due to the transboundary nature of the environmental problem and its economic repercussions. It is also clear that the classical generic tools in environmental policies for contaminating substances like state-of–the-art emission reduction techniques and the setting of (eco)toxicological quality standards fall short in view of the large-scale diffuse soil contamination. For soil protection we need to put the uses and functions of the soil-(ground)water-sediment system upfront and not the individual contaminating substances. The generic tools have to be adapted to fulfil their role as decision-making tools within a system-oriented management framework.

The analysis of regulations already in place that can contribute to soil protection against contamination has been the starting point for the working group and its task groups. Before any additional regulations or measures are proposed better implementation of existing ones or amendments concerning soil contamination are recommended. The reporting obligations at the EU level associated with these regulations already provide information that can be used for "action-driven" soil monitoring, but may have to be extended if necessary. For the further development of action-driven monitoring a scheme has been proposed for monitoring and assessment, based on indicators and a tiered approach. The working group discussed in depth the usefulness of classical soil monitoring to improve our insights in diffuse contamination. It proposed to start with an aggregation of the results of national monitoring approaches for heavy metals and POP's as listed by the Stockholm convention on POP's. However the need for new monitoring schemes is obvious in view of the large-scale diffuse pollution problem, in relation with monitoring requirements of the water framework directive and the groundwater directive.

A large input of the working group to the TWG Research was based on the RTD needs identified by the concerted actions CARACAS and CLARINET and the networks SEDNET and NICOLE. Concerning agricultural land uses many research questions are inspired by the lively discussions on compost, sewage sludge and fertiliser applications and more generally by discussions about Good Agricultural Practice, sustainable agriculture and the reform of the EU Common Agricultural Policy.

Organisation of the work

The general approach for discussion of soil contamination makes a distinction between source-oriented soil protection and contaminated land management. Source-oriented soil protection is aimed to prevent (further) contamination of the soil, while contaminated land management deals with the clean-up, remediation and reuse of soil which is already contaminated, often as a result of past activities.

Within this strategy framework, four workpackages and related task groups were established:

1) Policy, strategy and integration of issues (PSI), providing the common ground for the task groups and covering general policy requirements and cross-cutting issues;
2) Local sources (LS), dealing with prevention of contamination at the single site scale;
3) Diffuse inputs (DI), including agricultural sources, dealing with prevention of contamination due to diffuse inputs at the large and farmland scale;
4) Contaminated land management (CLM), dealing with remedial actions.

Common objectives of the task groups were the following:

a) Draw a general picture of the extent of soil contamination in the enlarged EU;
b) Describe strategies and technologies solutions;

c) Identify the added value of action at the EU level;
d) Define what should be monitored;
e) Make a research agenda.

The following sections will summarise the policy recommendations (based on objectives a, b and c), the monitoring recommendations (d) and the research recommendations (e) based on the work done by the task groups.

Main conclusions

Mandates and cross-cutting issues

The working group analysed all relevant mandates, identified the issues that are to be covered by the group and divided the work into work packages. Most of the issues have been covered, but a few have not been addressed due to time constraints, lack of expertise or low relationship with soil contamination.

The issue that could not be addressed in a quantitative way from the specific mandate was to assess the consequences of soil contamination hindering the achievement of sustainable development by addressing the impacts on economy, employment and social welfare.

Concerning the general mandate for all working groups, the basic principles (like polluters pay and precautionary principle) have been addressed by the working group and are reflected in the task group reports. Regarding policy needs a European soil policy should not replace current regulations, which already contribute to soil protection or duplicate these efforts but amend and complement these where required and act as a coordinating umbrella. The main philosophy of the working group is to stress the responsibility for soil protection and liability for soil contamination of the owner and/or user of the land. If soil users need to contribute to the improvement of soils contaminated by others, it will be obvious that some additional incentives will be needed. The role of agriculture and forestry in revitalising soils has to be seen in this light.

Concerning cross-cutting issues the following rough conclusions have been drawn in relation to soil contamination**:**

- ***Basic definitions:*** Protection against the threat of contamination has to consider the whole soil-water-sediment system and all kinds of (past and present) land use have to be addressed for the definition of appropriate measures.
- ***Climate change:*** Effects of climate change on the impacts of soil contamination, will be caused by changes in the water flow and organic matter status of soils. This will in turn influence the fluxes and the bioavailability of contaminants. The conclusions from the EU funded Chemical time bomb project (1991) are still relevant in this respect and need to be further explored to yield reliable scenarios in view of decision making.
- ***Environment and health:*** Apart from the clear human health risks associated with heavily contaminated areas the relation between soil contamination and human health is rather vague. In view of the uncertainties of the cause-effect relationships between soil health and human health a strong link between the Soil Thematic Strategy and the Strategy on Health and Environment is recommended.
- ***Biodiversity:*** There is clear evidence of adverse effects of soil contamination on soil biota and plants. Methods for ecological risk assessment should be further developed and further research is needed for implementation of specific indicators concerning the protection of biodiversity.
- ***Role of land use planning policy*****:** Land use planning should consider soil contamination, in particular in urban areas showing the need for consideration of soil degradation in the urban thematic strategy.
- ***Role of agriculture and forestry in revitalising soils:*** Guidelines and regulations for materials applied to agricultural are useful and further needed in order to avoid contamination, but also incentives are suitable to enhance soil protection, e.g. by reducing input of pollutants into soils.
- ***Co-ordination of the world-wide dimension*****:** Regarding large-scale diffuse contamination it is strongly recommended to develop synergies between the soil strategy and the Convention on Long-Range Transboundary Air Pollution.
- ***Awareness, communication and participation:*** Awareness raising on soil issues is very important in order to avoid soil contamination. Therefore provision of information is recommended using different tools adapted to the audience to be addressed.
- ***Property rights related to soil and soil data*****:** Data owned by public administrations has to be made publicly available, but also private data in case they are getting of public interest due to risk of damage to the environment.

<u>Issues that have not been addressed from the general framework:</u>

- Impact Assessment
- Socio-economic aspects
- Gender mainstreaming
- Basic typology and characterisation across European soils
- EU soil conservation service

Task group Local Sources

The **task group Local Sources** focussed on recommendations for preventing soil pollution from point sources. These sources only need the soil for support. Introduction of contaminants in the soil system can be avoided so the phrase “no added pollution” can be used to describe the strategic policy objective. The task group also provided an overview of major point sources contributing to local soil contamination.

The **main conclusions** of the task group are:

- In most cases soil pollution from point sources is unintended and happens due to handling spills or accidents or insignificant but continual losses/emissions. In contrast to air emissions and wastewater discharges, the principle of “controlled emissions” can not be applied and appropriate measures need to focus on pollution prevention.
- Soil pollution deriving from point sources shall be avoided as far as reasonably achievable whatever the state of soil might be at the beginning of an operation (“no added/increasing contamination”).
- Prevention of soil pollution from point sources is not sufficiently addressed in current EU policy (in contrast to emissions to air and water). Environmental liability in the case of pollution is weak and legally binding

financial security of potential polluters is entirely lacking.

- Point source safety for potentially soil polluting activities from industry, waste deposits, buildings, and extractive industries needs to be reviewed. In this respect special provisions to prevent emissions to soil need to be defined and the progress of their implementation needs to be surveyed.
- Monitoring of soil pollution from point sources can only be based on assessing policy efficiency in the sense of surveying the progress and efficiency of implementing measures intended to increase point source safety related to soil protection. Appropriate "policy monitoring" can only be implemented after implementation of appropriate policy adjustments at EU level and at Member State level.

Task group Diffuse Inputs

The **task group diffuse inputs** discussed two classes of soil contamination which are generally labelled as diffuse contamination:

1] Contamination that may arise from current agricultural practices and related soil uses such as forestry, managed nature reserves, reclamation areas, landscaping, gardens and parks where the user of the land modifies ecological processes in soil with additions of nutrients, exogenous organic matter and pesticides to increase productivity or to protect the current state of the land.

2] Contamination that enters the soil system by natural pathways like atmospheric deposition and sedimentation from surface waters (in the case of sediments).

These two classes have in common that the input from contaminants cannot be avoided like for local sources that only use the soil for support. In order to formulate adequate soil protection policies for diffuse contamination one has to address the interaction of the contaminants with the complex living soil system and its heterogeneity in space and time. Moreover contaminants enter the soil system by multiple pathways. Agricultural land may become contaminated through atmospheric deposition, through certain trace elements in fertilisers, through the application of pesticides, manure, slurries, sludges and compost or applied soil material. Another complication is the fact that many substances may contaminate the soil simultaneously and can interact, which may lead to additional adverse effects on some receptors.

The **main conclusions** from the task group are:

- Given the complexity of the diffuse input problem a strategic approach is needed that gives some indication how to consider the different inputs and their relations and how to pave the way to sustainable land use and soil conservation as a resource for future generations. European Parliament stressed the importance of preventing the accumulation of hazardous substances in soils, but the task group could not agree on the basic principles to turn this EP statement into a policy.

- Preventing accumulation of harmful substances by balancing inputs and outputs was considered a too simple "arithmetic" approach by some. According to them it is not the accumulation of the substance as such but the accumulation of risk for human health or ecosystems that should be the key issue. Others considered that focussing on (short-term) risk and current land uses is not preventive enough, in particular in relation to the Water Framework Directive. Risk assessments must be sufficiently knowledge-based and detailed to take into account future land uses and potential impacts in the long term in order not to be in conflict with sustainability. We should not want to endow future generations with risky soils and limit their freedom of choice to use the land differently.

- In view of the lack of consensus for a strategic approach, the group decided to use a bottom up approach, because they felt that was the most practical when discussing inputs of contaminants in agriculture. Materials like composts, manures, lime, fertilizers, sludges and pesticides can be assessed according to agronomic value, the impurities and potential pollutants can be identified, the pathways of exposure can be tracked and the risks for soil functions, water resources, plants animals and man can be assessed. This discussion automatically led to the question whether we should protect the multifunctionality of soils together with applying the precautionary principle, or whether we should make a differentiation between different types of land uses according to their sensitivity for pollution. Some favoured the long-term goal of preserving soil as a multifunctional resource for future generations, others favoured the more short-term risk based point of view related to the current use of the land.

- The weighing of agricultural benefits versus environmental impacts of each product proved also to be a controversial issue. This weighing is dependent on several political value judgements. Moreover the merger of the discussion about the sludge and biowaste from a waste management point of view with the discussion about soil protection did not contribute to the consensus in the group. One option is to define treated (e.g. composted) waste materials as product which is put on the EU market to be used for the improvement of nutrient status or organic matter content of soils. This strategy is applied in a number of Member States for composted biowaste (Austria, Italy, The Netherlands etc.). Another option as known from the Sewage Sludge Directive and national regulations is the strategy of waste recycling with the possibility to follow and control the recycling path until the application on a specific plot. In both cases agriculture must not be urged to serve as principle receptor of certain waste streams, but a distinct and comprehensive material and quality definition of waste derived soil amendments must ensure an environmentally sound beneficial use. In addition it has to be noted that, by definition, if a material is a waste does only depend on the fact, if someone wants to discard a material. On the first hand this is no matter of quality definition. The answers to these questions seem to require some general policy guidance. The more so because the added value of intervention at the EU level in regulations concerning waste, especially sewage sludge seems to be based on different arguments than for regulations concerning soil. Sewage sludge is produced locally and should be dealt with close to the source (it is not an example of transboundary pollution). Generally sludge is not exported as a recycled product to other countries (though it is sometimes transported over long distances), and whether sludge is burnt, landfilled or applied as organic fertilizer does not affect the performance of the internal market in EU or the balance of competition between Member States. However, organic waste recycling to

the benefits of the environment must go hand in hand with the needs of agriculture and more specifically the demands of soil protection.

Task group Contaminated Land Management

The **task group Contaminated Land Management** focuses on a risk based and sustainable management of land that has already been contaminated (= "historical pollution"). This accounts for diffuse contamination as well as for contamination coming from point sources. It also covers what has been termed recently as "proximity pollution", wide-spread diffuse pollution originating from a single industrial source, outside the property boundaries of the industry.

The **main results** of the discussions in the task group are:

1) The following definitions are proposed:

a) A *"potentially contaminated site"* is a "site where an activity is or has been operated that may have caused soil contamination".

b) *"Land"* represents a geographical area (could be a single site, or it could be a region such as a municipality or larger area). However, it also includes the physical components of this spatial area, such as soil and groundwater beneath the surface of the land.

c) *"Site"*: A particular area of land, usually related to a specific area of ownership or activity.

d) *"Contaminated land"*: a geographical area with confirmed presence of "dangerous substances" caused by man in such a level that they may pose a significant risk to a receptor in such a way that action is needed to manage the risks. The risk is evaluated taking into account current and expected uses of the land."

e) *"Contaminated site"*: a site with confirmed presence of "dangerous substances" caused by man in such a level that they may pose a significant risk to a receptor in such a way that action is needed to manage the risks. The risk is evaluated on a site-specific base taking into account current and expected uses of the site.

2) The management of contaminated land must follow the concept of Risk Based Land Management (as studied in the Clarinet-report) applied on a case by case approach. When a problem of new soil contamination is found immediate action is required.

3) Every MS should work out an action plan for contaminated land management.

4) Today, an EU-wide inventory has little relevance, because many Member States (MS) have a different understanding of what "contaminated site" means, and because the way and speed of building up inventories throughout the MSs differ greatly. That being said however, every MS (or county or region) needs information on potentially contaminated sites to be able to plan necessary management actions. This information can be grouped in an inventory. As decision for action can take into account other factors than contamination, it should be up to MS to fill it in depending on its own needs. EU-wide guidelines on how to build up an inventory of potentially contaminated sites as well as contaminated sites can be useful to exchange good practice in particular for MS not having such inventories.

5) Several Member States have carried out national action plans. Key principles and recommendations concerning such action plans are the following:

a) A strategic approach at national level is very useful in particular to define priorities for action based on the risks and the impacts of the contaminated sites.

b) An approach requiring a strong harmonisation of such plans at EU level is not appropriate. In particular MSs should have the freedom to decide whether the inventory or the plan should be carried out at national or regional level. MSs should also decide the type of inventory necessary to cover their territory (in particular a number of MSs have already developed such tools).

c) An information exchange on strategic approach between MS would be highly beneficial and should be developed to define best practices; the already established EU Common Forum may serve as a useful starting point here.

6) Information on soil contamination is often owned by private parties (e.g. land owner or operator); this information should be made publicly available, at least when contamination has been proven. MSs should be able to decide that they want all information on possible soil contamination to be made publicly available.

7) Application of the "polluter pays"-principle is not always possible for historical contamination, as the polluter may not be liable for historical contamination, may not be able to pay for remediation or does not exist any more. The recent Directive on environmental liability deals differently with soil damage versus water and biodiversity damage. The liability directive might have been an opportunity to protect/restore soil and land to the same standards as water and biodiversity.

8) The Proposal of the Commission for a Directive on Groundwater gives no solution for large zones of contaminated groundwater (for instance compliance with certain limit values is required in all points of the water body regardless the technical and economical difficulties to manage historical contamination). The Proposal should be amended to ensure an appropriate management of historical contaminated sites. In particular, the preventive and limit clause in the Water Framework Directive (WFD) may hinder remediation activities and should be clarified.

9) A need exists for a better harmonisation of risk assessment concepts. Much research has been carried out on the issue, and within the Caracas project an effort has been made to bring together all information within MSs, but little has been done to really co-ordinate the concepts. Some scientific elements relevant to risk assessment should be harmonized (e.g. stepwise and scientifically coherent decisional procedure, tox/ecotox/chem. contaminant properties) while others should be optionally selected from jointly developed "toolboxes" (e.g. sampling/analytical procedures, fate and transport models), in order to allow for site-specific and regional variability. MSs should be encouraged to harmonize their acceptable human health risk level e.g. excess lifetime tolerable cancer risk because differences are hard to explain to the public.

10) The "Best Available Technology" (BAT)-principle is relevant to make sure that best technologies are being used for soil remediation, while taking into account also secondary effects and costs of a technology. Guidance documents on proven technology may be helpful, while a strict list is likely to stifle innovation and development of new technologies. Implementing "BAT" should more be about procedures to come to site specific BAT rather than a strict list of what technology should be used for what type of contaminant. Examples of guidance documents already exist in several MSs, while also Clarinet- and NATO/CCMS Pilot Study reports provide useful information. When EU-funds include soil remediation in certain projects (like in funds for regional development, Interreg, Life, etc.) building in the necessity to use site specific BAT could trigger technology development and knowledge dissemination.

11) Some MSs have got mechanisms to co-finance the remediation by the present owner of contaminated sites where responsible parties have failed. Some EC-funding mechanisms (such as Interreg or European Fund for Regional Development) may fund soil remediation; they are limited though to certain regions. Yet, the application of the "state aid" regulation on soil remediation is not always very clear and should be amended.

12) The rights of an owner can interfere with "public interest", where e.g. soil contamination poses a threat to human health, groundwater quality, ecosystems, etc. The rights of an owner should be of minor importance to the public interest. Anyhow, an owner is an interested party in the soil quality, so he should take part in the decision making process of a remediation plan. To make the market "work" on remediation, the responsibility for the remediation could be put with the owner of the land, as this will make a remediation most effective; this can be "softened" with co-financing when the owner is not the liable party. Financial guarantees could also be required to ensure that industrial operators have the necessary funds to rehabilitate their sites when the activities cease.

13) Generally, greenfield development is too easy, thus hindering brownfield redevelopment.

14) A report on land status is desirable when a "risk activity" has been carried out on a piece of land to inform a potential buyer about the risks. One might even think of creating a "financial guarantee" at the moment of transfer to avoid constructions in which a liable party "sells" the badly contaminated land to an insolvent third party. Such a land status report should also be required in case of land use change toward a more sensitive use.

Recommendations

Recommendations for Policy

LOCAL SOURCES

Main recommendations of the task group are:

1. A commonly recognised list of potentially soil polluting activities from industry, waste deposits, and extractive industries needs to be drawn up and a distinction shall be drawn between those activities that shall be subject to EU policy and those that shall be subject to national policy regimes. A list of major sources was set-up by the Task Group which needs more detailed specifications.

2. In view of the enormous costs generated in the case of soil remediation, environmental liability needs to be strengthened. The Task Group recommends a regime of obligatory financial security, or insurances depending on the size and type of activity and the efficiency of implemented preventive measures.

3. Implementation of an obligatory soil assessment at the start and closure of potentially soil polluting activities.

4. Prevention of soil pollution from potentially soil polluting activities needs "tailor made" prescriptions and should be based on sector-specific or activity-specific precautionary measures. At EU level the Task Group considers IPPC BREF documents as the most suitable level to integrate soil protection measures in a sensitive way.

5. Consideration of early warning systems in landfills.

6. Consideration of soil pollution in mine waste management and reclamation of mining areas.

7. Incentives for operators → better insurance and liability conditions for proactive soil protection measures.

8. Improvement of point source safety at sites that are currently not covered by EU legislation, in particular small and medium sized enterprises (SMEs). Development of short guidance documents for prevention of soil pollution at potentially soil polluting SMEs.

9. Awareness raising at sites where potentially polluting activities are carried out.

10. Monitoring of point source safety with regard to soil pollution at EU level and Member State level.

DIFFUSE INPUTS

A general policy framework should be developed to address diffuse soil contamination resulting from atmospheric deposition, water pollution in the case of sediments, from agriculture and other activities like reclamation, landscaping and building activities. This policy has to achieve the following:

1. Specification of (ultimate) long-term goals and (proximate) short-term goals.

The long-term goal is related to sustainable land use and protection of natural resources. Balancing diffuse inputs with acceptable outputs of the soil and groundwater system in order to prevent a decline of soil functions seems to be the most appropriate long-term goal, whereas short-term goals can be based on the current risks of the contamination as related to land uses and functions and the bioavailability of the contaminants. Moderate surplus of diffuse inputs could be acceptable if the long-term goal is not endangered. The interaction between short-term and long-term goals need a thorough consideration, especially in relation to land use changes and cross-cutting issues like sustainable agriculture, mid-term beneficial aspects of certain soil management practices and climate change. Therefore function related soil quality definitions and investigations on critical concentrations of (potential) contaminants are an

important pre-requisite and reference for addressing GAP related to land management.

2. Specification of the responsibilities of the users of the land.

The user of the land should be addressed while taking into account that the user cannot be held responsible for all diffuse inputs. In the light of a "Good agricultural practice" a farmer should have the duty to be as eco-efficient as possible by minimising the flux of contaminating substances like heavy metals and organic pollutants coming from agricultural inputs and the flux of unused nutrients to groundwater and air. Suppliers and manufactures of products that are used on land and may impact on soil also have responsibilities to support the farmer in proper use of these products (quality assurance, guidelines for application).

Abatement of air and water pollution contributing to non agricultural diffuse inputs is a task for society as a whole. The long-term goal is to achieve a balance between inputs and outputs to groundwater into balance without compromising the quality of soil and water resources for future uses and functions taking into account the requirements of the water framework directive.

3. Ensure a linkage between soil protection policies and other related policy areas

Policy areas of relevance are policies approving chemical substances (including pesticides) for the market, policies concerning the quality of products applied on soils (fertiliser, compost) that may contain "unwanted" contaminating substances, policies for Good agricultural practices and policies concerning the use of organic waste on soil. Soil protection aspects should be taken into account, or enhanced where necessary, to ensure that there are no long- or short-terms threats.

There should be a more direct feedback loop from diffuse contamination and agricultural practice to the approval policies for chemicals and pesticides so that sustainable use in agricultural practice and prevention from entering the large-scale diffuse pollution pathways (deposition and sedimentation) can be improved. A stronger emphasis on persistence of chemical substances and pesticides in soil may be necessary in view of soil protection. The EU regulations on chemical substances and on pesticides should solve that problem. Further discussion about this issue for pesticides should take place in the Thematic strategy on pesticides and the current revision of 91/414/EEC Regulation on pesticides.

Concerning waste the policy should specify whether recycled waste can be used as a product or if it should be recycled in the framework of waste regulations.

If an application regime under waste regulations controls is chosen possibilities of a proper use of products are limited. Therefore for products high level of quality assurance, product declaration and quality requirements must be applied together with more and more emphasising GAP.

Specific recommendations for manure and slurries

1. In the long term, sustainable land use planning could encourage a better distribution of animal breeding and production in EU countries. One possibility to reduce unwanted inputs to soils would be to adapt the husbandry density (livestock unit per hectare) according to the environmental sensitivity of each area. Further recommendations are the following:

- Substitute manures and slurries for mineral fertilizer according to the needs of crops (good agricultural practices) in intensive breeding regions
- Develop treatments like biogas production that, on the one hand, improves the fertilization capacities of manures and slurries and, on the other hand, makes it easier to store and to handle. Appropriate land use planning policies are needed to ensure its development.
- Compost manures and slurries, which increases the percentage of stable organic matter in these materials and sanitises the manure but loses nitrogen. The benefits have to be compared with negative impacts like emissions of ammonia to the air which needs more research work.
- Decrease (if feasible) the amount of Zinc and Copper in the feeding of animals to a necessary level taking animal welfare implications into consideration as well as increasing the digestibility of diets to limit excretion in excess of N and P in the faeces after evaluation of potential benefit.

Specific recommendations for sludges

1. It would be desirable to refine the current EU sludge directive to achieve a holistic approach to all organic resources that are applied to all types of land in order to have soil protection based, harmonized requirements for all of them.

2. It would be desirable to improve the definition of treatment and preferably to move to the protocol that has been adopted buy the food industry and that is progressively being required of farmers, i.e. Hazard Analysis and Critical Control Point (Codex, 1997; Evans, 2003). HACCP is equally applicable to chemical as well as to microbiological hazards.

Specific recommendations for compost

1. A positive list of high quality source materials for composting and anaerobic digestion intended for the processing of organic soil amendments would be essential to guarantee high quality compost. This should include source separated household waste and green waste as well as organic industrial waste (e.g. from food industries).

2. In order to bridge the gap between targets for the reduction of biodegradable municipal waste to landfill and a sustainable use of the biodegradable waste fraction incentives for the recycling of source separated biowaste are essential. Member States are encouraged to explore the best solution for implementation considering local conditions.

CONTAMINATED LAND MANAGEMENT

1. As a starting point for individual monitoring at risk activities, it is interesting to start with a soil quality monitoring duty for operators who already have an existing monitoring and reporting duty, such as IPPC. An amendment to the directive should be made to specifically reference soil monitoring activities in the duties for operators. To make sure

that the activities with higher risks for soil contamination are covered, an investigation should be carried to define the main contaminating activities which are not yet covered by the IPPC-list.

2. It seems necessary to clarify "satisfactory state" in IPPC, as interpretations differ at the moment throughout MSs.
3. Every MS should work out national or regional action plans for contaminated land management.
4. Contaminated land policy comprises both soil and groundwater contamination. We need an integrated approach to soil and water.
5. Water-soil interaction is very important for dealing with sediment problems. Sediments should be included in soil strategy.
6. Create an incentive to the harmonisation process for risk assessment.
7. Promote the use of the RBLM concept to manage historically contaminated sites in an efficient and sustainable way.
8. Soil should be protected at the same level as other environmental compartments in the coming Directive on environmental damage.
9. The text of the "state aid" regulation should be amended or at least clarified to reduce uncertainties about possible public incentives which for instance aim to bring brownfield sites/regions back into the economic cycle, to solve urgent problems which pose a high risk, etc.
10. Create a legal basis for the public availability of aggregated data on soil quality of contaminated sites.
11. Create incentives for the redevelopment of brownfield areas; this implies often creating extra protection against greenfield development.

Recommendations for Monitoring

DEFINITIONS

The term "monitoring" is used in this report as general term covering classical soil monitoring, multi-purpose monitoring, action-driven monitoring and regular reporting using various indicators or other type of information across the whole DPSIR chain.

"Classical monitoring" is the measurement of concentrations of substances in soil (monitoring of state). Multi-purpose monitoring and action-driven monitoring are defined in the Monitoring mandate. We consider multi-purpose monitoring as the monitoring of the state of soil for all threats to fulfil different needs, whereas action-driven monitoring is focused on the evaluation of policy measures against soil degradation.

"Regular reporting" is the periodic communication of aggregated information resulting from national monitoring programmes, according to an agreed format.

GENERAL RECOMMENDATIONS

Classical monitoring is only useful in well-defined stratified approaches. The group recommends that detailed monitoring is carried out only in problem areas. Many parameters have to be measured in order to interpret the observed changes in the state of soil with respect to contaminants. There should be a recommendation for reference standard methods for sampling and analysis and for standard specification of what to report and how to report it. Monitoring of soil should be integrated with monitoring of sediments, groundwater and surface waters. A European approach should be based on information provided by the national monitoring programmes. Related to the different threats an explicit identification of problem areas or risk zones is needed. Criteria for identification of risk zones should be agreed with the Member States.

The following recommendations are mainly referred to 'action-driven' monitoring which is considered the most appropriate approach to monitoring and assessment of soil contamination. For this reason particular relevance is given to action and policy-relevant indicators, which are usually collected at a relatively high – i.e. by country - aggregation level. However a number of indicators and parameters might be considered in order to get less aggregated information needed to carry out a more detailed, and still action-driven, monitoring down to specific problem areas. Details on the choice of contaminants to be monitored are also provided.

1. The implementation of the soil information and monitoring system on soil contamination should follow a progressive upgrade in terms of quality and quantity of information collected. The system architecture and individual data collection items will be updated along with the improvement of the information basis that will be available with the enforcement of a harmonized EU Soil Protection Policy.

2. The system should be built on systems already in place both at the European and national level.

3. The system design should be implemented following a dynamic and flexible nature and devised to fulfil short-term requirements, mainly based on a number of already available and comparable indicators and parameters at the different spatial scales. Long-term needs should also be identified.

4. The monitoring and assessment system of soil contamination should be based on the following elements:

    a. Action-driven monitoring
    b. Identification of relevant indicators and related data needs
    c. Integration with existing European monitoring and reporting activities
    d. Integration of local and diffuse contamination
    e. Streamlining (not extensive multi-purpose monitoring but based on specific policy needs)
    f. Tiered approach, according to the following geographical levels:
        i. Country
        ii. Catchment (regions of natural boundaries)
        iii. Site-specific-European Level (full EU coverage limited to pressures; detailed monitoring limited to problem areas)
        iv. Site-specific- national Level (limited to guidelines for national inventories))
    g. Step-by-step implementation and harmonisation (gradual implementation and learning by doing)
    h. Guidelines for national monitoring (data collections activities, national inventories, etc.).

5. The Driving Forces-Pressures-State-Impacts-Responses (DPSIR) assessment framework should be used to identify and prioritise the policy-relevant indicators to include in the system.

MONITORING OF LOCAL SOURCES

The measurement of concentrations of substances in soil and groundwater are planned to detect failure of the technical preventive measures as fast as possible. Therefore they are of little relevance in terms of providing an overview of the state of the soil (or groundwater) with respect to contamination.

For this reason, monitoring of local sources should make use of more aggregated information like failure frequency of specific preventive technologies or general policy performance indicators (see also monitoring recommendations from task group contaminated land management).

Main recommendations of the task group are:

1. Establishment of a European Point Source Assessment System (EPSAS). Safety conditions at defined point sources should be monitored on a regular basis. The system should cover activities included in an agreed common list of potential soil polluting activities. A distinction should be made between activities subjected to EU policies and activities subjected to national regimes. The system should be based as far as possible on existing activities.

2. At the European level, EPSAS should cover those installations that are currently obliged to report their environmental standards on a regular basis. These are industrial installations as defined by the IPPC directive, installations addressed by the regime of the Seveso II directive, exploratory industries addressed by the new BAT document of the IPPC directive, and landfills that come under the regime of the landfill directive.

3. At the national level, on the basis of an agreed list of potential soil polluting activities, Member States should be encouraged to monitor point source safety at other installations or activities which are currently not covered by EU legislation (i.e. small enterprises with relevance for soil pollution).

4. Existing information should be improved and expanded:

    - **Industry:** in the long term the European Pollutant Emission Register (EPER) should be extended to provide information on the efficiency of soil protection at IPPC sites
    - **Mining:** Member States should compile and report national overviews of sites which need to comply with new standards and progress in standard implementation.
    - **Waste management:** further development of the EEA electronic waste catalogue and integration in EPSAS of reporting under the hazardous waste directive and the landfill directive.

5. The EPER register should be extended to include emissions to soil.

6. The status of strategic industries (i.e. Seveso II) should be reviewed, including any installation and waste sites of the military sector

MONITORING OF DIFFUSE INPUTS

Sources of contamination from agricultural practices

The monitoring in farm systems of input-output balances of the concentration in soil of selected contaminants and nutrients may help the improvement of GAP (good agricultural practice). Given the large number of farms in the EU, information to be reported to the EU should be aggregated in policy-performance indicators or sustainability indicators.

It should be noted that plant protection products although applied to plants or soil are more often monitored in plants and groundwater than soil, as required by the Pesticide (91/414/EEC), Drinking water and Water Framework Directives. In some cases (risk areas) monitoring the amount applied to soil may be useful but additional information is required to relate this to potential environmental impacts, such as described in Directive 91/414/EEC. Hence it would be relevant to monitor certain of these products in soil solution as well.

Large scale diffuse pollution

This is the policy area where monitoring is of most importance and relevant at EU level because of the transboundary nature of large-scale diffuse pollution. Monitoring the fate and transport of contaminants through environmental media will help the choice of the best national and regional abatement strategies and their effectiveness. Because all environmental compartments are involved, soil and sediment monitoring should be linked to the monitoring of surface water, as required in the Water Framework Directive, to the monitoring of groundwater, as required in the Groundwater directive, and also linked to the monitoring of air pollution. The EU monitoring system could use already existing networks as a starting point. Even if the methods used differ between networks, the conclusions may still be consistent.

Substances to measure

Measurement of concentration of contaminants in soil should focus on the abatement of (current and future) effects due to diffuse inputs. It should also include the effects of measures to reduce inputs. Monitoring should only be done where there are real concerns (risk areas) rather than a routine grid sampling. The choice of substances should consider only those substances which may reach critical limits in soil in view of human health, food safety, soil fertility, ecological risks especially concerning biodiversity in soil, groundwater and surface waters. Those include the following:

- Heavy metals (Cadmium, Copper, Lead, Zinc, Mercury, Arsenic, Nickel and Chromium)
- Polycyclic aromatic hydrocarbons (PAHs)
- Dioxins, polychlorinated biphenyls (PCBs) and other dioxin-like substances
- Banned, persistent pesticides, such as hexachlorocyclohexane (HCH), dichlorodiphenyltrichloroethane (DDT) or DDE
- Nutrients (nitrogen and phosphates).

Use of the results of measurement of substances in soil

Results from a monitoring programme should enable the user to:

- Evaluate the impact (= quantity and quality) of diffuse inputs in relation to other inputs (e. g. what is the contribution of atmospheric inputs compared to inputs by manure?). This will, later on, steer the measures to be taken to reduce inputs according to relevance.
- Evaluate the future state of the system, i.e. how does the current land use (or changes thereof) affect soil quality. Again, soil quality in relation to crop growth, water quality, ecosystem etc. This means that input-output (balance) approaches are needed that are able to calculate fluxes into (inputs), within (processes) and out (outputs) of the system. Based on the outcome of these balance approaches, inputs can be reduced or effects can be reduced (accept a certain input but make sure effects are negligible, e.g. by additional liming).

Frequency

An average sampling interval of 5 to 10 years seems to be an adequate compromise to measure changes in the metals and organic contaminants listed above, which are likely to be slow as well as nitrogen, phosphorus and the inputs/outputs of contaminants to/of the soil system, which may change faster. If more knowledge of the dynamics of the various parameters is available, the sampling frequency could be adjusted accordingly for each parameter.

Representativity and spatial resolution

To be representative for EU soils, a monitoring network should cover the major forms of land use, climate, hydrological regime and soil type, as strata in a stratified sampling design. Although monitoring could be done on an arbitrary grid basis, it is not very efficient to consider soil as a black box system and ignore that land uses, soil types, climate and hydrological regimes are major factors determining the influence of diffuse inputs on the state of soils. Stratified sampling is much more powerful in this case because it addresses these factors explicitly and will make interpretation of data much easier. We need to take into consideration the distribution of driving forces/pressures and the receptors of contamination (not just the distribution of physical parameters).

Specific recommendations for (action-driven) monitoring of exogenous organic matter (EOM)

Due to the usually low quantity of pollutants and limited amount of material applied to land (following GAP) accumulation rates are generally low. If source materials as well as the gained exogenous organic materials (including manure) are of well defined quality (limit values) it would be fairly enough to monitor changes on pilot scale where pure modelling would still leave considerable uncertainties. In this way (as mentioned below) basic data taking into account the most important management and site conditions can be considered.

Collecting these data may be useful also for scientific purposes, to improve conceptual models of substance flows in agricultural systems. A number of farming systems maybe monitored through EU and such a monitoring system may help to improve GAP (good agricultural practice)

There exists research based evidence that the input of humified organic matter (compost) increases the sorption or fixation capacity for heavy metals in soil. So monitoring of heavy metal availability/solubility/mobilisation within *pilot schemes* with plots fertilised with EOMs would be an important tool for further evaluation of potential impacts due to the input of contaminants by fertilisation systems. Also persistent organic pollutants (POPs) and their breakdown/solubility behaviour which may be found in those EOMs could be considered to be monitored in this way. But currently this may rather be a matter of research than of regular monitoring system.

MONITORING OF CONTAMINATED LAND

Measurements of contaminant concentrations in soils are needed to assess the risks of contamination on a one-off basis or in relation to long-term management plans. In both cases monitoring will be specific for the site and of limited representativity, unless there is a larger number of similar sites. For these reasons, only for very large sites (megasites), where risk management plans are at the regional scale (like for instance “the Kempen” in the Netherlands and the Flemish region, the old coal and steel region in the North of France, or the Bitterfeld area in Germany), reporting of monitoring data may be of EU interest.

Data on concentrations of contaminants at individual sites (there may be 1.000.000 sites in EU) make little sense for EU policy discussions. Therefore, EU relevant information about contaminated land problems and solutions should be reported in the form of policy performance indicators.

The monitoring of contaminated land should have the following objectives:

1. gather data on the quality of soil according to risk-based principles, i.e. land use fitness and protection of resources
2. identify where action is needed
3. assess the efficiency of the actions undertaken and of the effectiveness of policy in place.

There is a strong need for tiered monitoring: at national or regional/catchment level a monitoring strategy is desirable to know where action is required, at EU-level it may be interesting to aggregate the collected data to give an idea about the effectiveness of the policy in place. The monitoring objectives are also linked to the discussion under “definition”; following that item, “aggregated parameters” or “indicators” might be:

1. Number of potentially contaminated sites
2. Number of sites that have been investigated
3. Number of sites where action is needed
4. Estimated amount of money needed to undertake action
5. Number of sites where action has been undertaken
6. Amount of money spent in action

Other interesting parameters/indicators (giving a broader view) might be:

1. Technologies used for remediation: this parameter gives an idea about the “sustainability” of

remediation concept and may serve as a driver to initiate use of new technologies in other Member States.

2. Surface of brownfields known and dealt with: those parameters/indicators may serve as a signal for site remediation as driver for sustainable land use

3. Some sites may have such a serious impact on other relevant fields (so called megasites or problem areas), that reporting at EU-level on specific parameters for this site could be interesting. A definition of a megasite could be: "site where pollution is so bad that is has EU dimension (meaning that the site is relevant for existing EU-policy). Examples may be sites where the quality of a (ground or surface) water bodies is endangered, where food safety is endangered or a site that has a big social impact. A report on such a site could comprise parameters such as the location, kind of hazard (what EU dimension is "close") and the management concept for the site.

4. The main principles on monitoring could be in a directive, details on the monitoring scheme and on the reporting should be in a technical guideline.

EU INFORMATION MANAGEMENT FRAMEWORK: A STEP-BY STEP APPROACH

Monitoring and reporting approaches need to evolve into a more harmonised EU information management framework. EU Monitoring has to start with aggregating the already existing monitoring schemes and will identify the need for harmonisation and additional monitoring information for the interpretation of the results. Reporting has to start by using already defined program performance indicators and will have to accept some differences between Member States. As policy will become more uniform due to the EU soil strategy, policy implementation differences between Member States will gradually disappear and policy performance indicators will become more comparable.

So, both for monitoring and for reporting, we need to accept that the first results will give a rather blurred image of the DPSIR for soil contamination. But the quality of the information will improve gradually if information exchange and harmonisation of approaches is stimulated. There is a need to report aggregated information on agreed formats.

Recommendations for Research

LOCAL SOURCES

1. Further development of containment devices and techniques for safe storage, handling and transport of substances that may contaminate soil and groundwater.

2. Passive sampling technologies work contaminant specific and are a promising technology for early warning of soil pollution. However, absence of performance data from lengthy use and other uncertainties prevents their availability on the market. Further improvement on product development is needed to improve economy and reliability of such devices.

DIFFUSE INPUTS

General recommendations

1. The availability of substances (to plants, animals and soil micro-organisms) that reach the soil from either atmospheric deposition or agricultural activities, both chemical and biological, and changes therein with time. Specific issues that need to be addressed include P-availability in soils, change in heavy metal availability with time, effects of organic matter and pH on availability of metals and organic micropollutants in soils (link with organic matter group; specifically in relation to compost addition, see additional remarks on compost discussion)

2. Practical tools (i.e. measurement techniques) to assess the degree of biological availability of substances in the soil that can be used to assess the internal levels. Here especially crop uptake and exposure of toxic substances for soil organisms have to be addressed.

3. From 1 and 2 it is obvious that some degree of consensus on the concept of bioavailability is needed since it forms a crucial aspect. If bioavailability in some form or another is to be implemented in EU policy, there should be some agreement amongst scientists what is meant by bio-availability. Further on it is an important to take scientifically based steps for the definition of critical soil threshold concentrations. This cannot be done by setting one value of a contaminant for all soils, land uses and climates. But without such an orientation all technical debates on risk-based assessments and precautionary principles etc. become obsolete

4. Field based process studies that establish process information at the desired level. Often process knowledge obtained in laboratories is insufficient to explain the behaviour of substances under field conditions. Especially retention and transport of substances like P, metals and organics have to be addressed in order to be able to link levels in soils to those in ground- and surface waters.

5. Investigate feasibility of development of true Farm and Field gate balances that take into account all in- and outputs. Currently various outputs (crop uptake, leaching, gaseous emissions) are not properly quantified or even neglected.

6. Knowledge on long-term changes in soil in relation to changes in land use (conversion of arable land to forest or wetland, extensivation, changing groundwater tables, changes in salinity due to irrigation or intrusion of sea water)

7. An overview of effects of available and new management strategies on environmental impact. For example the change from low to high inputs systems of organic manure may result in higher nitrate losses to the groundwater.

8. The economic impact (both form farmers and governments) of changing regulations on the allowed content of unwanted substances. For example reducing the amount of cadmium in P-fertiliser will result in higher prices for fertiliser. What are economic consequences for this?

9. Organic matter decline can be compensated by organic fertilisers, like animal manure, sewage sludge or compost. How do these potential sources for soil organic matter compare to the real natural input (decomposition of the local vegetation)and what are the long-term consequences for the soil and the surrounding ecosystem?. How is the life support system and biodiversity affected by current "high input- high output" agriculture?

10. Establish long-term field scale experimental sites across the EU where EOM is used at controlled rates that approximate to GAP. The sites should span the breadth of climatic and soil types found in the EU. The sites can be a resource to experimenters wanting to research the long-term effects of EOM.

Specific recommendations for manure and slurry

1. Digestibility of diets of animals and more efficient use of Cu and Zn in the diet, according to the real needs of animals

2. Regarding management, plant nutrition and soil protection:

    - Mineralization kinetics of organic matter and organic N
    - Availability to crops and leaching to groundwater of N, P at field scales
    - Characterization of organic matter (easily degradable or stable fractions)
    - Effects of organic matter on soil (increase of microflora, stabilisation of soil structure…)
    - Development of models and software predicting the mineralization and availability of nutrients
    - Development of models predicting and quantifying the effects of organic matter on soil

3. Regarding the prevention of soil pollution and the protection of soil ecosystems:
    - Effect on soil ecosystems of N and P accumulation
    - Speciation of trace elements and links with bioavailability
    - Extraction, analysis, transfers and impacts of veterinary drugs
    - Characterization and behaviour of pathogens in manures and slurry

4. Regarding the socio economical aspects
    - How to change the regional distribution of animal production in EU?
    - How to de-concentrate animal breeding in EU countries?
    - How to incite such changes?
    - What will be the socio-economical and technical impacts of such changes?

Specific recommendations for EOM

The regular use of EOM on Agricultural land imposes 2 main challenges to be covered:

1. optimisation of OM and nutrient supply (=soil improvement)
2. diminishing potential adverse effects due to load with accompanying contaminants.

A lot of applied research has been conducted for a number of materials such as animal manure, sewage sludge and, recently since 10 to 15 years also for compost.

Especially for compost from source separated organic waste long-term impacts on the soil-plant-groundwater system (agro-ecosystem) are still missing and do not reflect all typical ranges of soil, climate and land management conditions. Therefore in order improve GAP (good agricultural practice) for the organic fertilisation systems specific networks should be established covering the use of exogenous organic matter (EOM, such as compost and sludge). Existing mid and long-term field trials must be integrated in order to profit from the already existing data pool. Harmonisation of *what* is being measured and *with which methods* is needed as well as completion with missing soil, management and climate variations. Parameters identified as effective indicators for soil quality and function can easily be integrated in such a co-operative research/monitoring network.

Key parameters related to soil contamination would be:

1. Various forms of *nitrogen* (nitrogen pools)
2. the *emission of greenhouse gasses (N_2O)*
3. the impact of spreading EOMs on *phosphorus-fractions* and their mobilisation potentials
4. The long-term effects of increasing the *sorption or fixation capacity for heavy metals* in soil by humified organic matter and dynamics are not fully understood in the view of precaution.
5. Accumulation, decay and solubility of *persistent organic pollutants* (POPs).
6. Potential hygienic problems resulting from the use of "*fresh compost*"
7. Impacts of the one-time use of higher amounts of composts (100 to 400 t/ha) in *land reclamation*.
8. The above mentioned effects (point 1 to 9) of *digestate* as compared to compost.

CONTAMINATED LAND MANAGEMENT

Many issues related to risk assessment management have been identified in the CARACAS and CLARINET concerted actions and by the NICOLE industry network. These recommendations are given in an annex to the task group report.

In view of the need to integrate water protection, soil protection and prevention of air pollution a system-oriented approach is required in contrast to approaches focussing on individual substances. Feasibility of a river basin scale system-oriented approach should be scientifically explored, including demonstration projects. The system approach will require the development of conceptual models of the system we need to manage. The conceptual model will suggest (among others):

- What to monitor and where,
- The most promising measures to improve the environmental quality of the system
- The best way to conserve the quality (e.g. protection of non-contaminated ecosystems)

In addition the Task group on Contaminated land management identified the following research needs:

1. There is a strong need for harmonised analysis and sampling procedures. If not enough political agreement can be found to achieve this in a short term, effort should be put in attaining common performance standards such as accuracy and precision of the processes. Sampling and analysing have to be oriented as much as possible to the objective of the monitoring: whether one is interested in concentrations or in possible effects may have a strong influence on the kind of analyses that have to be carried out. There is a strong wish for risk-oriented sampling/analyses to get a better understanding of the possible effects of a contamination, rather than getting an idea about concentrations of a certain substance, without any notion of possible risks and without any notion of the potential effect of a cocktail of hazardous substances.

2. Focus research on giving better estimations of transfer of contaminants to possible receptors via the different transfer routes.

3. Sustainability of remediation concepts: most remediation concepts have an environmental impact themselves: emissions of volatile compounds, traffic, energy consumption, while on the other hand some concepts require long-term (sometimes even eternal) management. Most often, information about those environmental impacts and impact of this long term care is very scarce.

4. Easy-entry decision support tools for BAT: a lot of research has been carried out already on remediation techniques, but the information is not easily accessible for the end-users. There is a strong need for a good instrument for information exchange on remediation technologies. Such an instrument should be created at an EU-wide level. Projects like Eugris offer help, but have the disadvantage that they stop at a certain moment.

The status of soil contamination in Europe

In many areas of Europe, soil is being irreversibly lost and degraded as a result of increasing and often conflicting demands from nearly all economic sectors.

In Western Europe (WE), pressures result from the concentration of population and activities in localised areas, economic activities and changes in climate and land use. Air depositions and cultivation systems are among the most important influences on the quality of soils in agricultural and natural areas. Consumer behaviour and the industrial sector are contributing to the increase in the number of potential sources of contamination such as municipal waste disposal, energy production and transport, mainly in urban areas.

In Central and Eastern Europe (CEE), many of the problems stem from past activities and poor management practices.

The combined action of these activities affects quality and limits many soil functions including the capacity to remove contaminants from the environment by filtration and adsorption. This capacity and the resilience of soil mean that damage is not perceived until it is far advanced.

This partly explains the low priority given to soil protection in Europe until recently. Moreover, since soil is a limited and non-renewable resource, when it is damaged, unlike air and water, it is not easily recoverable.

The geographical distribution of soil degradation depends on several factors. Soil problems are influenced by the diversity, distribution and specific vulnerability of soils across Europe. They also depend on geology, topography and climate and on the distribution of driving forces. Better integration of soil protection into sectoral policies and better harmonisation of information across Europe are needed to move to more sustainable use of soil resources and promotion of sustainable models of its use. In particular, soil contamination from diffuse inputs and local sources can result in the damage of several soil functions and the contamination of surface water and groundwater.

In WE, soils in agricultural and natural areas are still in an acceptable state with respect to contamination but are under pressure. If pressures continue at the current level, as it is already evident in some problem areas, impacts will start to occur on a larger scale. Because the negative effects on the quality of soils are hard to remediate, these pressures should be addressed in time. On the other hand many urban soils and sediments are already heavily affected. Prevention should stop further deterioration and the risks of the currently contaminated land should be adequately managed.

Soil degradation problems in the CEE countries are quite similar to those in WE. Most of the problems are inherited from the time of the former USSR, when environmental issues were of minor concern.

Past agricultural policies that focused on increasing productivity led to often unsuitable use of mineral fertilisers and pesticides.

The combined effects of these resulted in pollution of groundwater and reduction of soil fertility. Increased awareness of environmental issues, the obligation to implement EU legislation upon accession and declining economies are reducing the pressures from agriculture (decreases in fertiliser and pesticide consumption).

In CEE soil contamination is, to a great extent, a result of the legacy of inefficient technologies and uncontrolled emissions.

Problem areas include some 3 000 former military sites, abandoned industrial facilities and storage sites which may still be releasing pollutants to the environment (DANCEE, 2000). One of the major impacts is groundwater contamination and related health problems. Major concerns are the long time needed to regenerate contaminated soil and the considerable investment required for remedial measures.

Contamination with radioactivity is also important as a result of nuclear weapons tests, improper radioactive waste disposal and the Chernobyl accident (UNEP, 1998).

MONITORING

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Monitoring soils is quite different from monitoring air and water. The spatial variability of soils is very great and requires a customized approach that takes this feature fully into account. It is also important to remember that soils are *relatively* stable, so that their properties, once formed, tend to remain unchanged over space and time. Soils in Europe are particularly rich and diverse, with many different soil types occurring in different climatic regions, therefore a specific mechanism needs to be developed in order to address this variability. The information available about soil variability can be derived essentially from the 1:1,000,000 scale soil database of Europe located within a European Soil Information System (EUSIS). This data set, together with other information sources, allows for a preliminary representativity analysis for different monitoring strategies.

Thus, different approaches are required for each of the recognised threats to European soils. While some of the threats may require systematic monitoring, most of the other threats need a more focused approach, taking into account the fact that they do not occur everywhere in Europe (soil erosion, soil compaction, salinization, soil sealing, floods and landslides). Stratification of European soils according to susceptibility to each of the single threats would allow development of targeted monitoring approaches for each of these.

Future soil monitoring at the EU level should be based, as far as possible, on existing monitoring systems. A complete inventory of the National monitoring systems that Member States and Accession Countries may wish to include in and integrate into a future European Soil Monitoring System would allow an in-depth analysis of the representativity of these systems, both in terms of the diversity of soil types (and their associated ecosystems) and of land uses in Europe. Additional analysis of these systems for their ability to represent the various soil threats should be performed, based on a pre-stratification of European soils according to each of the single threats listed in the communication COM 179 (2002). The analysis will allow determination of whether existing soil monitoring at the National level covers adequately both soil/landscape diversity for general monitoring purposes and each of the individual threats for action driven monitoring purposes. Eventually, the analysis might yield the conclusion that, in some parts of the EU, additional soil monitoring sites need to be established. Such a conclusion should be submitted to a detailed cost/benefit analysis. A monitoring site is defined for the purpose of this report as a precisely geo-referenced location where soil observations and measurements are performed in a standardised and documented way at regular time intervals

As a result of the discussions within the Monitoring Group, the following structure seems to be an adequate basis for a pragmatic approach:

- The starting point of the soil monitoring process will be a **basic inventory / baseline** (i.e. equivalent to time zero) for comparative purposes. Therefore the definition of the baseline for all future comparisons and activities is essential.

1. In the short term, it became obvious that one single common baseline, taking into account all threat-specific aspects, will not be achievable. On the other hand it is neither effective nor helpful to deal with parameters or indicators not relevant for the respective question or site. There could be a need for an analysis of the performance criteria required to illuminate each threat at the appropriate scale, i.e. number of observations required to give a specified level of detection of change, for example. This would be an underpinning research task.
2. As the first step, adequate and more detailed requirements (e.g. number and location of sampling points according to the results of a representativity analysis – see also performance analysis, above) are to be developed for the different threat-adopted baselines. This first step has to be prepared in the framework of the soil strategy.
3. As a second step, all existing data and mapping (especially 1:1,000,000, but also other relevant data sources) shall be used to evaluate and define the relevant regions for each of the 8 threats at the EU-level. This could result in a useful stratification of threats (and the parameters and indicators necessary to their monitoring) at a number of geo-political levels, e.g. state, region, catchment, etc,

- Adequate parameters/indicators for regular monitoring, appropriate time scales, measuring intensity, etc., relevant for EU-policy decisions, must be derived from within the competences of the EU taking into account other directives of concern (e.g. 2000/60/EC, 2001/18/EC) and be orientated to answer questions which have to be previously defined and accepted, and this is a task for a future Co-ordination Group.

- **The monitoring system** should be built up carefully. The system should be brought into use step-by-step using existing soil monitoring systems and linked with other existing relevant information systems as effectively as possible. This means, that the system should include what can be done in the short term and also as far as possible with a minimum financial burden. In this first step, the general principles must be set out, including a first set of indicators, parameters, and agreed methods that are already available or achievable within a short time-frame (about 2 years).

- **The soil strategy** has to deal with open questions, non-obligatory measures and research-related issues. The indicators and parameters which can be achieved and become practicable only under medium and long-term monitoring frameworks would also become part of the strategy.

- Other relevant data already existing at the EU-level should be integrated in the soil monitoring directive (e.g. GMES, land use/land cover, forest soils, nitrate directive, air, water…). A close link with related Community initiatives, such as INSPIRE, GMES, LUCAS and others, should be established.

- The DPSIR model will not apply to soil-monitoring itself, but it should be used as a basis for the choice and selection of adequate parameters/indicators to make developments and the reasons for changes in soils visible, since it can be used to explore the complex inter-relations between all the factors affecting soil protection. The DPSIR model can also be used to structure and help assessments and to prioritise monitoring activities. In addition to the parameters for classical monitoring, the DPSIR model is helpful in identifying indicators and reporting mechanisms for action driven monitoring.

In conclusion, we need to propose effective soil monitoring for Europe which, in the first step, is based on existing resources (no significant additional costs). This implies that monitoring in this first step will have to be based on existing systems and information. Existing

systems are already either financed by EU programmes (e.g. LUCAS, GMES) or by National funds. In MS where there are no existing monitoring initiatives, we strongly encourage such National authorities to establish such a system as a matter of priority.

There are only a very few examples in Europe of fully operational soil monitoring systems. Many of the systems reported by Member States have performed only one observation in time. The few operational systems allow some conclusions to be drawn :

1. Soil is a fairly stable medium, with changes usually detectable only over long time spans (more than 10 years, depending on the parameter considered).
2. Variability in space is often larger then variability in time, making the precise geo-referencing of measurements over time a mandatory requirement.
3. Establishing a well-organised archive of soil samples facilitates backwards comparison of results over time.
4. Variability in sampling and measurements is often larger then variability over time, making stringent standardisation and QA/QC procedures a mandatory requirement.
5. Observed parameters in existing systems are strongly biased by availability of measurement methods, with a strong predominance of observations related to soil contamination (mostly inorganic pollutants) with only little information on the other major threats to European soils.
6. There is a strong need for research into monitoring methods for threats such as decline of soil biodiversity and soil physical degradation,.
7. Access to information produced by soil monitoring is subject to different legal requirements in Member States, with strong implications of private ownership and confidentiality for georeferenced soil data.
8. Lack of EU coordination in implementing the above recommendations suggests that the creation of an EU Soil Monitoring Co-ordination Group, perhaps as an element of a possible Soil Conservation Service, would be helpful.

Existing systems in Member States are organised according to different sampling schemes, with some countries adopting regular grid approaches and others using a stratified approach according to pre-defined representativity criteria. The only EU wide monitoring system covering all land cover / land use types (LUCAS) has adopted a regular 18x18 km grid covering all Member States. It includes basic parameters measured in a harmonized way at the EU level such as land cover (bio-physical description of the ground) and land use (socio-economic function) relevant as additional information to monitor soil erosion, soil organic matter and soil sealing. Two surveys have been already carried out in 2001 and 2003 and the next one should be organised in 2006 in the EU25.

Parameters are the properties of the soil, or components of the system of which the soil is a part, or surrogates for them, which are measured or otherwise assessed in order to quantify the threat(s) to the soil in space and time. A parameter can be used directly as an indicator of the kind and magnitude of a threat to soil and its functions or it might be used in the development and elaboration of a soil indicator of soil functions.

Because of the anthropogenic nature of many of the threats to soil, the potential list of parameters that could be of concern at some time or another is extremely large, especially for chemicals. For this reason, the approach is taken that considerable local discretion will be needed in selecting parameters that most clearly reflect local problems and concerns. On the other hand, we **recommend** a basic list of parameters to be measured or assessed that relate to current EU Directives so that overall assessments of the nature of these potential threats to soil can be made at the Community level *sensu lato*. This approach allows Member States and other States to add to the list of parameters in order to address their local concerns.

For harmonization, the TWG has identified two **requirements**:

1. The need to assess comparability of existing data so that maximum value can be obtained from past and current soil monitoring or soil inventory activities. We believe that this is best dealt with through assessments by experts coupled, where necessary, by some inter-laboratory comparisons based on Certified Reference Materials (or other agreed materials).

2. The need to harmonize future activities, which should include protocols as well as QA/QC procedures for:

    - the selection, location, setting up and maintenance of monitoring sites
    - site and soil descriptions
    - sampling strategies
    - laboratory procedures including storage of soil samples
    - data handling and data storage

The TWG **recommends** strongly that, wherever they exist, use should be made of the normative methods produced under the auspices of ISO and CEN. Such use should be mandatory and backed by legal powers within the Directive. The TWG also **recommends** that the Commission should support strongly the development of further normative methods relevant to the aims of the Soil Monitoring Directive.

If a certain site, located on privately-owned land, is of special concern and necessary from the representativity point of view, a solution has to be found to allow access to this site within the mechanisms of national legal frameworks. First of all, a solution on the basis of a contract should be envisaged. Most of the Member States have legal provisions to force, if necessary, private landowners to tolerate certain measures as long as those measures are unavoidable and in the special interests of the general public. There seem to be no real practical problems which could not be overcome. From a subsidiarity point of view, there is no need for an EU-wide unique solution.

Access to public properties is also regulated by national legislation.

The use of data for commercial use or remaining in private hands either for the future EU monitoring system, or deriving from it, has to be regulated by contract.

Possible elements to become part of a BINDING INSTRUMENT needing further discussion to find the contours of the future EU monitoring system:

- Even if we use the same wording there often is a different understanding what is really covered by them. Therefore the need for precise definitions.

- The **scope** has to be defined. There is a need to clarify that only mandatory obligations will be part of a legally binding instrument.
- **Design** of the future soil network. Which and how many sites shall form the network?
- Clarification of **responsibilities** between EU and Member States.
- Responsibility for the gathering, storage and publication of the information delivered by the competent Member State authorities.
- Obligation and time frame for a **report on soil status** at regular intervals to the public, the European Parliament and the European Council.
- Linking with or integration of other EU-level available data bases with relevance to changes in soils and/or of relevance for the proper interpretation of monitoring results.
- An obligation that for every parameter/indicator the relevant method of analysis and data evaluation must be listed.
- Regulations for the financing of the monitoring system.
- Rules for the future development of the directive (phasing in of new elements, step II and further consequences.

There was a common feeling that it could be very helpful to establish a Co-ordination Group to assist the Commission during the elaboration of its proposals. The group will be responsible for the production of proposals for technical guidance and protocols for the collection, quality assurance and quality control, storage and distribution of information. This action should be based on the evaluation of existing soil monitoring processes and their component parts, and take into account the suggestions from the various Working Groups.

Task Group "Review of existing monitoring systems"

Task:

1. Analyse and compare existing monitoring, survey, GIS, inventories and mapping systems in Member States and Accession Countries, highlighting the most efficient features.
2. Make recommendations on the network of observations and monitoring procedures to be followed (periodicity, design and structure, authorities involved, quality checks, etc.)

Summary

A detailed analysis of existing monitoring, survey, GIS inventories and mapping systems in Member States and Accession Countries has allowed us to gain a comprehensive knowledge about such systems in Europe. A possible way of systematising this very variable and inhomogeneous information is to organise the different sources of information according to three main classes: **Soil maps**, **soil inventories** and **soil monitoring systems**.

Soil maps are available at different scales and using different classification systems and legends in all EU Member States and Accession Countries. They are the results of extensive soil surveys performed in the past 50 years in Europe, mostly for agricultural purposes. There has been no common European approach to soil survey and mapping, with different countries developing different procedures and traditions. Countries with a more structured and developed National soil survey have often developed also a National soil classification system, with measurements and parameters observed that vary greatly between different countries. Detailed soil mapping (1:50,000 or larger) is available only in some countries. Historical developments have strongly influenced the soil survey activities, with Eastern European countries developing very detailed soil maps for centralised planning purposes, but using diverging classification and measurement methods compared to Western Europe. All countries in Europe have a common 1:1,000,000 scale soil map developed jointly within the framework of the European Soil Bureau activities of the European Commission. Most of the existing soil maps are still available only on paper, particularly in Accession Countries.

Soil inventories are often developed starting from digitised existing soil maps. This has been the case of the European Soil Database at 1:1,000,000 scale, but also of many of the National soil inventories. The general adoption of GIS technology and the creation of databases of georeferenced soil information have allowed a number of new types of assessments producing more policy relevant information than the previously available soil maps. Modelling approaches using the existing soil inventories allow us to derive information such as soil erosion risk, organic matter content, diffuse contamination, soil compaction, salinization, etc.. Systematic inventories are usually the pre-condition for the establishment of a soil monitoring system. This is the case for the European forest soil inventory with regular observations on a 16 x 16 km grid, but also for many National inventories. The establishment of a common European baseline for the establishment of a European Soil Monitoring System seems mandatory. Some early attempts were made by the European Commission in this sense, with the initiation of a European georeferenced soil database at a scale of 1:250,000.

As regards the monitoring of local soil contamination deriving from point sources such as industrial sites or landfills, or 'hot spots' (where more serious problems occur, and in general need (priority-sactions by the competent authority), the great majority of EU15 countries keep registers as an instrument to document the extent of contaminated sites' problems and to administer the management of these sites. According to the long-term progress in managing the contaminated sites' problem, registers are in continuous progress. Inventories are kept either at national or regional level; content and structure depend on the legal requirements in the Member States concerned. It is common to all of the registers that they refer to "sites" (potentially) posing risks to human health or to the environment. All of the registers include at least information on industrial sites and landfills; due to the country-specific situation additional categories such as mining sites, military sites, accident sites, or stocks of potentially hazardous materials, might also be registered. In any case, the information kept refers to historic contamination; however, there is no common understanding on the term "historic"; some countries also include data on actual soil contamination. Almost all of the Member States keep information on sites with ongoing as well as abandoned industrial activities; just a few countries restrict information on non-active sites.

In addition to problems in the EU15, new Member States face problems *inter alia* with former military bases, oil contamination due to broken pipelines, and pesticide stocks, so that identification and registration also of these sites pose a central task in environmental policy. In a few of the new Member States, registers for contaminated sites already exist; some countries are just setting them up.

There are only very few examples in Europe of fully operational **soil monitoring systems**. Many of the systems reported by Member States have performed only one observation in time, i.e. they are **inventories**. The few operational systems allow some conclusions to be drawn:

1. Soil is a fairly stable medium, with changes detectable usually only over long time spans; depending on the parameter considered this could be more then 10 years, especially for heavy metals and some organic pollutants.
2. Heterogeneity in space is often greater then variability in time, making the precise georeferencing of measurements over time a mandatory requirement.
3. Establishing a well-organised archive of soil samples facilitates backwards comparison of results over time.
4. Variability in sampling and measurements is often larger then variability over time, making stringent standardisation and QA/QC procedures a mandatory requirement.
5. Observed parameters in existing systems are strongly biased by availability of measurement methods, with a strong predominance of observations related to soil contamination (mostly inorganic pollutants) with only a little information on the other major threats to European soils.
6. There is a strong need for research in monitoring methods for threats such as decline of soil biodiversity and soil physical degradation.
7. Erosion, local contamination and soil sealing, as well as floods and landslides, would need an indicator-oriented approach, rather than classical monitoring. Here statistics taken in administrative geographical units (including statistics on agricultural land management) have to be overlain with soil characteristics (soil risks and potentials) to come to a more aggregated information base (e.g. using modelling for the problem of actual erosion risk).
8. Access to information produced by soil monitoring is subject to different legal requirements in Member States, with strong implications of private ownership and confidentiality for georeferenced soil data.
9. Lack of EU coordination in implementing the above recommendations suggests that the creation of an EU Soil Conservation Service (as in par. 2.5.4. "EU soil conservation service" of the Framework Mandate) is needed.

Existing soil monitoring or inventory systems in Member States are organized according to different sampling schemes, with some countries adopting regular grid approaches and others using a stratified approach according to pre-defined representativity criteria. The only EU-wide monitoring system covering all land cover / land use types (LUCAS) has adopted a regular 18x18 km grid covering all Member States. It includes basic parameters measured in a harmonized way at the EU level, such as land cover (bio-physical description of the ground) and land use (socio-economic function) relevant to the monitoring of soil erosion, soil organic matter and soil sealing. Two surveys have been already carried out in 2001 and 2003 and the next one should be organized in 2006 in the EU25.

Final conclusions and recommendations are:

1. Establish a common EU-wide soil inventory (baseline) containing general soil parameters and specific parameters (see task group report on parameters) for each threat to soil as identified in COM 179 (2002).
2. Select a minimum set of common parameters (see task group report on parameters) to be monitored on an agreed set of sites (see task group on variability of soils), which should be part of the existing soil monitoring systems at the National level.
3. Promote the adoption of standardized methods and procedures (see task group report on harmonization) for the measurements of the selected common parameters.
4. Organize regular quality control/quality assurance procedures including also laboratory ring tests, benchmark sites, training/education in soil classification and sampling, etc.
5. Establish a regular reporting procedure (e.g. 5 years) for the selected parameters from the Member States to the European Commission.
6. Explore the possibility of achieving stronger EU coordination of soil monitoring activities through an EU Soil Conservation Service.

Task Group on "Parameters and indicators to be monitored"

Recommendations

1. As part of the future strategy for soil monitoring and protection, there should be an evaluation as to whether all the parameters, listed in this report, are equally relevant and necessary for EU-wide monitoring. This is part of the debate as to whether 'one-size-fits-all'. There is agreement that examination of these issues should be part of a 'next-steps' approach to soil monitoring.

2. The monitoring of soil has to be seen as an integrated part of environmental monitoring. This should include classical monitoring of substantial soil contamination as well as of indicators of structural changes in soils.

3. There should be a programme of basic measurements of soil parameters at each monitoring site which forms part of an EU-wide network, in order that the soil at each site can be linked adequately to existing data such as those represented by the 1:1 000 000 European Soil Map. There is also a case for more targeted monitoring at fewer sites to inform specific problems or threats.

5. GMES, LUCAS and other EU environmental programmes should be examined as possible added information by which monitoring of some of the soil threats might be made.

6. The case for the monitoring of those Drivers, Pressures and Impacts that present further threats to soils, and Responses adopted to counter them, should be further examined under a 'next-steps' procedure.

Introduction

Parameters are the properties of the soil, or components of the system of which the soil is a part, or surrogates for them, which are measured or otherwise assessed in order to quantify the threat(s) to the soil in space and time. A parameter can be used directly as an indicator of the kind and magnitude of a threat to soil and its functions or it might be used in the development and elaboration of a soil indicator of soil functions, i.e. interpretation is required. It may be useful and valid to examine the usefulness and desirability of parameters in terms of the Drivers, Pressures and Impacts that they might reflect, and in terms of Responses adopted. Not all parameters may be useful across all Member States, so an element

of subsidiarity may need to be brought in to obtain maximum value for least cost.

This is reflected in the anthropogenic nature of many of the threats to soil. The potential list of parameters that could be of concern at some time or another is extremely large, especially for chemicals. For this reason, the Working Group believes that considerable local discretion will be needed in selecting parameters that most clearly reflect local problems and concerns. On the other hand, we recommend a basic list of parameters to be measured or assessed that relate to current EU Directives so that overall assessments of the nature of these potential threats to soil can be made at the Community level *sensu lato*. This approach allows Member States and other States to add to the list of parameters in order to address their local concerns. A particular problem is that of local contamination (including 'hot spots'), e.g. industrial sites, in which the parameters of potential interest *and that are amenable to direct measurement* are almost impossible to specify in advance of targeted investigation, site-by-site, without committing organisations to potentially large costs - many of which might prove unnecessary.

The WG also agreed that it would be sensible to integrate soil monitoring parameters with those measured for other soil-related purposes, such as that of ICP-Forests. The WG did not define the precise mechanisms for such integration, but identified it as a task for a 'next-steps' exercise. Further work also needs to be done in relation to the relationship between specific parameters the precise nature of the (perceived) threats to soil, and the frequency and density at which the observations should be made. It is also essential that the lists of parameters (and indicators – see below) are reviewed at regular intervals in order to assess the case for both additions and deletions.

It is axiomatic, in our view, that data sources of all kinds should be taken into account when both designing a soil monitoring network and the ways in which data might be accrued, e.g. we have in mind such things as environmental statistics (see also DPSIR (below), remote sensing, existing inventories, modelling). Further consideration should also be given to the potential linkages of monitoring of air and water with those of soil, and *vice versa*.

General parameters

It is essential that Member States and the Commission obtain maximum value from information collected through either multi-purpose (MP-SM) or action-driven (AD-SM) soil monitoring. In order to do this, site characteristics need to be linked to existing datasets such as the European Soil Map at 1:1 000000 scale. This linking could permit much robust extrapolation, if coupled with a sensible degree of expert assessment and cross-validation. In order to do this effectively, certain basic parameters are required to identify the soil and site characteristics.

The WG has agreed that the basic parameters for the effective characterization of soils at sites to be monitored are (either by measurement or estimation, as appropriate):

- Soil profile description according to an agreed International System. This will include a wide range of observations such as soil structure, evidence of compaction, status of the soil surface, depth the impermeable layers, stoniness etc.;
- Soil classification according to an agreed International System, such as the World Reference Base;
- Identification of soil parent material to an agreed system;
- A sampling design that allows for long-term, robust assessment, i.e. it is essential that the inherent variability of the site can be separated from long-term change;
- Site characteristics, such as slope, aspect, historical and current land use and land management recorded to an agreed system;
- An agreement is required on sampling depth (by horizon, by fixed depth or both; when sampling by depth steps, information on the limits of the relevant horizon is necessary)
- Soil bulk density;
- Stone content and stone size (and their inverse - the solid spatial architecture of the soil);
- Particle size distribution (sand, silt, clay) in an agreed number of classes;
- Soil pH (water, an electrolyte);
- Soil cation exchange capacity
- Soil water holding capacity;

The determination of these basic parameters will form a substantial part of any start-up costs of a soil monitoring network, something which is discussed further below.

Specific Parameters

As one of the next steps, it is essential to differentiate parameters into those that are obligatory and those that are not (facultative parameters). The latter should be monitored on a case-by-case basis in relation to the needs of the Member States depending on special purposes or regional questions. It was generally agreed within the WG that the parameters related to specific threats are as follows, but it is also recognized that several of the general parameters might also be relevant to specific threats, and would need to be brought into any assessment of these.

The WG agreed that there could be a strong case for the stratification of monitoring sites. Thus, for example, the baseline sites could be regarded as Level 1. These would be the sites at which all the general parameters would be measured. In this way, these sites would offer maximum added value because they would readily link to existing databases such as EUSIS and to similar national databases within Member States.

On the other hand, the WG Monitoring is, like many of the Working Groups, acutely aware that not all desirable parameters can be measured at all sites and that there are many instances such universal measurement would be pointless and not cost-effective. One example would be the determination of the parameters for salinization in regions where such a threat has been absent historically or is never likely to occur within a meaningful time-frame. WG Monitoring is also aware that an element of expert judgment will be involved in the selection of these issues and parameters under the proposed 'next steps' procedures.

We propose, therefore, that consideration should be given to the creation of so-called Level 2 and Level 3 sites. We envisage that the former would relate to the investigation and monitoring of specific parameters and threats, and might well be strongly linked to research activities. Further investigations of, for example, erosion mechanisms or biodiversity might well be addressed properly through such sites. We hesitate to suggest a 'quota' for such sites,

but something of the order of 10 per cent of the baseline sites might be adequate to permit a proper investigation, in detail, of a named threat at enough sites to be able to inform the discussion and assessment oif such a threat across al, Member States. Clearly, however, further consideration of this suggestion would be appropriate under a next-steps procedure through the proposed Co-ordination Group.

Level 3 sites could be related to very specific problems, e.g. radio-nuclides, military sites, decontamination of specific industrial residues, 'hot-spots' of anthropogenic or natural processes, or they might be regarded a benchmark sites for very specific research problems or cross-Community issues. Again, we consider that discussion of such an approach would fall naturally into the remit of a Co-ordination Group.

It has not escaped the notice of the Group that the Level 1 sites would also greatly assist the reconsideration of the representativity of any soil monitoring system at some point in the future. A network of this kind requires enough buffering to be able to withstand the loss or relocation of some sites over a long period.

Threats: Soil organic matter ands biodiversity

Recommended parameters for soil organic matter:

For general purpose monitoring (Level 1) of the threat to soil organic matter, the Group recommends that the following be measured:

- Total organic carbon
- Total (organic) nitrogen,
- The C:N ratio derived from these.
- Bulk density

For Level 2 sites, it was agreed that the following parameters might also be measured, depending on the progress in research on methods, standards etc.

- SOM compartments and pools
- with a physical separation + biochemical characterization (FTIR…)
- Top layer description
- Bioavaibility of nutrients and pollutants (toxicity)
- Measurement of fluxes: in water or air (emissions of GHG)
- + test of aggregation
- Forest soil monitoring
- Land occupation and practices
- Exogenous organic matter input
- Carbon hot spot monitoring: soils rich in OM but also depleted and degraded soils (desertification)

For Level 3 (benchmark sites), the following parameters were proposed:

- **Microflora**
- microbial biomass
- measurement of some biological functions (respiration, N and C mineralization..)
- diversity where molecular signature are now widely used (indicator of genetic biodiversity)
- Activity
- Carbon mineralisation (basal respiration)
- Diversity
- **Fauna**
- Nematodes,
- Earthworms or total macrofauna

Threat: Soil erosion

Recommended parameters: As '*next steps'*, the WG Monitoring accepted the advice of the Task Group Erosion that soil monitoring *per se* , i.e. through on-the-ground measurements, should not be done for erosion ***at present***. Assessment of soil erosion should be done by up-dating at regular time intervals the baseline produced through modeling in the status report of the TWG soil erosion (see report from TWG erosion). This will be achieved by the collection of updated land cover/land use information (CORINE, LUCAS, GMES, National data, etc.), improved geomorphological data (DEM's, etc.), more detailed soil information (National data) and improved rainfall data. This modeling approach will allow the land-surface of the EU to be stratified into areas of actual erosion risk, potential erosion risk, and little erosion risk, e.g at the catchment scale. In this way, effort in on-the-ground monitoring will be directed in a cost-effective and focused way. Such an approach does not preclude the future establishment of specific monitoring initiatives for soil erosion in dedicated sites (these would be Level 2 or Level 3 sites depending on the nature of the problem to be investigated, its pan-European component(s), and the degree of research effort required). Within that background, the following topics might have to be considered, many of which are covered by the parameters suggested elsewhere for other threats and thuis form part of the whole ethos of added value:

- Land use data and land management data (vegetation cover)
- Meteorological data
- Topographical data
- Soil data

Surface particle size class, Soil depth, Soil type

MANDATORY physical soil parameters:

- Bulk density
- Solid particledensity
- Pore size distribution
- Saturated hydraulic conductivity (Ks) - laboratory measurements

MANDATORY chemical parameters of the soil solid phase

- Ctot, Corg

OPTIONAL physical soil parameters:

- Unsaturated hydraulic conductivity (Ku) - laboratory measurements
- Hydraulic conductivity (Ks and Ku) - field measurements
- Penetrometric (or cone) resistance
- Aggregate stability
- Soil-water content, volumetric
- Soil-water tension

- Monitoring soil erosion *sensu stricto*

Measurements at the plot scale
Measurements at the catchment scale

- Mapping visible soil erosion features
- Continuous measurement of sediment loads at the outlet of small catchments
- Measurement of sediment deposition in ponds, lakes or reservoirs.

- Monitoring on site impacts

Threat: Soil Contamination

WG Monitoring broadly accepted that different approaches will need to be taken to the monitoring of widespread (diffuse) pollution and local contamination, including 'hot-spots' where urgent action might be required. Local contamination can present particular problems in that it is often site-specific and might not have a clear spatial relationship to the surrounding diffuse pollution footprint.

Parameters to be monitored for diffuse soil contamination (Level 1 sites):

'Total' element concentrations in soils are commonly measured to give an indication of the total soil resource. 'Total' in this context is often taken to mean that fraction extractable by hot *aqua regia* solution. The aqua regia extractable fraction of heavy metals is a widely used standard method. However, relatively large "total" metal concentrations can be of natural origin, and in many cases these natural concentrations are weakly mobile and not bioavailable. Natural background should be investigated at least from a subset of sampling sites. There is a strong case for linking the elements of interest to those likely to increase from atmospheric deposition, from additions of sewage sludge, or from other wastes, and these relate strongly to various existing Directives. The suggested list at present is as follows, but there may need to be considerable local latitude to allow for particular circumstances in Member States, although we recommend that, in the first instance, this list should not be shortened, i.e. it is a minimum data set:

- Arsenic (As),
- Cadmium (Cd),
- Chromium (Cr),
- Copper (Cu),
- Mercury (Hg),
- Nickel (Ni),
- Lead (Pb),
- Phosphorus (P) and nitrogen (N): nutrients connected with eutrophication,
- Zinc (Zn)

There may also be a need to determine a range of organic compounds, such as persistent organic pollutants (POPs), dioxins, di-benzofurans, PCBs, PAHs, pesticides (e.g. HCH, DDT, DDE). Similar arguments can apply to radio-nuclides such as radio-caesium, radio-iodine etc. However, not all Member States will need to undertake such work, and, certainly, very careful thought needs to be given to the density of observations required to establish meaningful baselines for these parameters in the different regions of the EU25. Thus, we do not recommend that these parameters should be universally determined, or that they should form part of a minimum data set for all Member States.

In addition, application of sewage sludge on agricultural land, base saturation and heavy metal accumulation in topsoil should be included. Total element concentration in soil parent material (same elements listed above) should be measured at selected sites in order to assess the 'natural' background.

Parameters to be monitored for local soil contamination (including 'hot-spots') (Level 2 sites):

The general conclusion is that the parameters measured at such sites, **which would undoubtedly include many of those mentioned above**, cannot be specified as part of a general monitoring framework, because the requirement depends entirely on the local circumstances. This is particularly true of the very large number of anthropogenic organic compounds. Thus issues of kind, frequency, and appropriateness are still unresolved. However, it was broadly agreed by WG Monitoring that certain *Indicators* should be used to track the nature and magnitude of local soil contamination, as well as some Pressures and Responses:

1. Progress in contaminated site management;
2. The number of contaminated sites at each stage of management;
3. Site specific information;
4. Registers of contaminated sites;
5. Area and catchment-specific information;
6. Unused industrial land;

The suggested indicators should be structured as follows:

1. Country level: Progress in contaminated sites' management

- Number of identified and estimated total number of potentially contaminated sites
- Number of sites where investigation measures are in progress
- Estimated total number of sites where investigation measures are necessary
- Number of identified and estimated total number of contaminated sites
- Number of sites where remediation activities are in progress
- Estimated total number of sites where remediation activities are necessary
- Number of sites where remediation activities are complete

2. Area related level
   Collection of data being of relevance for the total area (e.g. total impact on soil being of relevance for water management at catchment level). Reporting of aggregated data.

3. Site specific level
   Collection of site specific data at national level. Sites can either be large-scale single sites being of EU relevance or "Mega Sites" (agglomeration of individual sites, integrated management required). Reporting obligation for selected data at site specific level.

Level 3 sites would probably encompass both very specific contamination problems, e.g. radio-nuclides, military contamination, major chemical facilities and so on, and could also form a focus for research effort. It was agreed that, due to the complexity of the potential combinations of problems and related parameters, many of these issues will have to be addressed on a case-by-case basis.

Threat: Soil Sealing

Monitoring of soil sealing can be obtained from appropriate statistics, as is already done by the Member

States and collected by EUROSTAT. Effort is needed to find common definitions on the proportion of sealed soils in built-up areas, which also includes private gardens, green areas accompanying transport corridors etc. Harmonization of definitions between member states is needed. WG Monitoring broadly agreed that an approach is needed that both reflects the nature of the amount of soil sealed, the kind of soil being sealed, and the rate (intensity) of soil sealing. The most successful approach is likely to be based on remote sensing. The joint initiative GMES (Global Monitoring of Environment and Security) between the EC and ESA (European Space Agency) aims to develop operational services using remote sensing data by 2008, with the aim of improving the data quality for environmental reporting in relation to the soil thematic strategy and especially on the threat to soils due to sealing.

Threat: Soil compaction:

The ecological impact of soil compaction is reduced soil aeration and subsequently reduced rooting density and rooting depth. Soil compaction also has an effect on soil infiltration and on run-off potential. WH Monitoring broadly agreed that the spatial assessment of compaction was difficult to monitor and was strongly affected by land-use. The only parameter put forward was bulk density.

Threat: Floods and Landslides

WG Monitoring was broadly in agreement that this threat was best approached at the trans-national level, with Member States co-operating in the definition of 'flood' and 'landslide', e.g. extent, magnitude, duration, economic aspects. It was also broadly agreed that the initial approach should be indicator-based. Once appropriate definitions of indicators are agreed, it is proposed that there should be development of the following during a 'next steps' period. In the meantime, the suggestions from WG Monitoring are given below for information:

- **European reporting**
  - Occurrence and localisation of events over a certain size (criteria to be specified) and their environmental, social (loss of human life, displacement of people) and economic impacts (damage to buildings, etc.)
  - Localisation and characterisation of areas at risk (limited to areas that have European relevance; criteria to be specified)
  - Costs of remediation and compensation
  - Plans and management systems in place
  - Further information on evolution of soil sealing in risk areas

- **Development of indicators**
  - Occurrence of landslide and flooding events
  - Impacts of floods and landslides
  - Management of hydrogeological risk
  - Preparation of maps of areas subject to hydrogeological risk.

Threat: Salinization and sodification

WG Monitoring agreed that salinisation was a problem likely to be of local extent and should be addressed by individual Member States, although there was no agreement as to how the results of such local assessment should be reported. In areas prone to salinization (these would probably be Level 2 sites), the following parameters are suggested (again note how many are already included in 'General Parameters'):

- Granulometric composition,
- Profile description.
- Catchment scale:
- Soil organic matter,
- Electrical Conductivity,
- Sodium Adsorption Ratio (water and soil extract),
- Bulk density,
- Saturated hydraulic conductivity, aggregate stability*,
- Slope,
- Ground water level,
- Soil water content,
- Soil vegetation cover fraction.
- Plot scale:
- water retention curve,
- unsaturated hydraulic conductivity,
- soil shrinkage characteristic curve,
- Cation Exchange Capacity,
- exchangeable ions,
- sediment production,
- soil loss.

The use of the DPSIR Model

We regard the application of this model to each and every possible parameter as unnecessarily time-consuming **at this stage of development**, but we recommend that this be reviewed by the proposed Coordination Group. Similarly, we were unable to come to an agreed position, within the time available, on what can be achieved with indicators versus parameters, and we thus recommend that this question is visited further by the proposed Coordination Group. However, we clearly recognize that the DPSIR framework could provide useful information on those processes which lead to changes in the pressures on soils and, perhaps, their state, e.g. economic activity (increase in buildings, roads, construction of factories etc.), the drive to increase crop yields and the agronomic advice associated with this, the need to dispose of more waste to land (kind of waste, kind of land to receive it), and so on. This might well include consideration of the monitoring of preventative measures and suggest ways in which the effectiveness of such measures might be assessed.

Task Group on harmonization Recommendations

1. Existing data should be harmonized as far as possible, e.g. through expert assessment and a programme of trans-national comparison under a 'next-steps' procedure, so that maximum value can be obtained from past and current soil monitoring activities.

2. There is a need to harmonize future activities, which should include protocols for, but not necessarily restricted to, the selection (taking note of the principle of representativity), location, setting up and maintenance of monitoring sites, site and soil descriptions, sampling strategies, laboratory procedures, data handling and storage, and quality assurance.

3. The Commission should support strongly the development of further norms relevant to the aims of the Soil Monitoring Directive.

4. The Commission should undertake, with considerable urgency, a formal cost-benefit analysis of soil monitoring.

5. The Commission should assist in the development of a mechanism whereby all the costs of soil monitoring can be calculated in an open and transparent manner.

6. Adequate time frame for entering into force must be respected and set before a new method becomes obligatory.

General

The TWG identified two requirements:

1. The need to harmonize existing data so that maximum value can be obtained from past and current soil monitoring activities. We believe that this is best dealt with through assessments by experts coupled, where necessary, by some inter-laboratory comparisons based on Certified Reference Materials (or other agreed materials). We recommend that there should be a next-steps exercise to achieve this.
2. The need to harmonize future activities. The latter should include protocols for, but not necessarily restricted to:

- the selection (taking note of the principle of representativity), location, setting up and maintenance of monitoring sites
- site and soil descriptions
- sampling strategies
- laboratory procedures
- data handling and storage

Many of these issues are covered elsewhere in this report. The WG Monitoring recommends strongly that, wherever they exist, use should be made of the normative methods produced under the auspices of ISO and CEN. Such use should be mandatory and backed by legal powers within the Directive. If a Member State requests derogation with respect to a particular norm or norms, then it must produce evidence, acceptable to Commission experts in the relevant field, that the performance of the proposed national or local norm is equivalent to that of the procedure stated in the Directive.
The TWG also recommends that the Commission should support strongly the development of further norms relevant to the aims of the Soil Monitoring Directive. The current norms are listed in Annex 3 of the task group report on Parameters and Harmonization.

Costs of monitoring and harmonisation.

The Task Group was unable to undertake a cost-benefit analysis of soil monitoring as it did not posses the requisite skills in this area of economic science. The TWG recommends that the European Commission should undertake such an analysis with considerable urgency. Similarly, there is no agreed method for deriving the costs of soil monitoring within Member States. It is clear from discussions that there can be considerable hidden costs within such programmes. The WG Monitoring recommends that the costing of soil monitoring should be examined more thoroughly in order to evaluate properly the true costs and the long-term costs, e.g. of sample storage, quality control over decades, data handling and storage etc., few of which are included in the figures below. Figures were supplied for the purposes of comparison by Germany, Hungary, Portugal and the UK. These figures are based on recent monitoring activities adjusted, as far as possible, to current prices. A VAT component has been included only for Portugal. No attempt has been made to harmonize such things as overhead rates. The figures should, therefore, be taken as indicators of costs in representative Member States' economies. It is far from clear to what degree hidden costs are included, especially those of a long-term nature. The WG Monitoring is of the opinion that the costs of soil monitoring are unlikely to be found within standard current programme budgets. Experience suggests strongly that all successful monitoring programmes have been funded by a special programme, set up for that specific purpose, within the relevant Member State.

Reporting

The WG was unable to agree on the precise details of a reporting mechanism for the information collected under a pan-European soil monitoring exercise (although some aspects of this are partly considered under 'Private Ownership', below). However, such a mechanism needs to be developed and should include such fundamental issues as units of measurement, precision of reporting, geo-referencing, database structure(s), guardianship of, and access to, information, confidentiality, intellectual property rights and so on.

Task Group on "Variability of soils"

Task:

Develop a mechanism to reflect and address the variability of soils in the EU, in particular looking at the possibility of using soil typologies and characterization as a basis for the development of customized monitoring.

Summary

Monitoring soils is quite different form monitoring air and water. The spatial variability of soils is very great and requires a customized approach that takes this feature fully into account. Likewise, because soils do not 'mix' to a great extent over relatively short-time periods, one cannot assume a smoothing function between very different but adjacent soils.

Soils in Europe are particularly rich and diverse, with many different soil types occurring in different climatic regions, therefore a specific mechanism needs to be developed in order to address this variability. The information available about soil variability can be derived essentially from the 1:1,000,000 scale soil database of Europe located within the European Soil Information System. This data set allows for a preliminary representativity analysis for different monitoring strategies, either grid based and/or stratified.

Different approaches are required for each of the recognised threats to European soils. While some of the threats might require systematic monitoring on a grid basis and /or stratified monitoring (soil organic matter, diffuse soil contamination, loss of soil biodiversity, soil compaction) other threats need a more focused approach taking into account the fact that they do not occur everywhere in Europe (local soil contamination, soil erosion, salinization, soil sealing, floods and landslides). Stratification of the European soils according to susceptibility to each of the single threats would allow developing targeted monitoring approaches for each of these. This would also allow proper consideration of the appropriate sampling density in relation to the threat(s), the parameter(s), and the indicator(s).

Future soil monitoring at the EU level should be based as far as possible on existing monitoring systems or inventories. A complete catalogue of the National monitoring and inventory sites that Member states and Accession Countries may wish to include in the list of

relevant sites for monitoring soils at the European level would allow an in-depth representativity analysis of these sites, both for representativity of the diversity of soil types and of land uses in Europe (and, by implication, their functions). Additional analysis of these sites for representativity of the single soil threats should be performed based on a pre-stratification of the European soils according to each of the single threats listed in the communication COM 179 (2002). The analysis will allow determination of whether the existing soil monitoring at the National level is adequately covering both soil/landscape diversity for general monitoring purposes and each of the single threats to soils for action driven monitoring purposes. Eventually, the analysis might yield the conclusion that in some parts of the EU additional soil monitoring sites need to be established. Such a conclusion should be submitted to a detailed cost/benefit analysis prior to any further decision on additional sites.

Final recommendations are:

1. Establish a stratification of the EU and Accession Countries for each of the eight threats to soils using existing information including a report on the methodology used in order to determine priority areas for each threat.
2. Acquire from the Member States and Accession Countries the precise coordinates of each existing soil monitoring site that is planned to be included in the future European Soil Monitoring Network.
3. Perform a representativity analysis for the monitoring sites that have been reported by Member States and Accession Countries taking into account soil type, land use and the stratification according to threats.
4. Evaluate the opportunity of establishing additional sites on the basis of the representativity analysis and of a separate cost/benefit analysis.

Task Group on "Private ownership"

Summary

If a certain site located on privately-owned land is of special concern and necessary from the representativity point of view, a solution to the problem of access to that site and its investigation and reporting, has to be found within the mechanisms of national legal frameworks. First of all, a solution on the basis of a contract should be envisaged. Most of the Member States have legal provisions to force, if necessary, private landowners to tolerate certain measures, as long as those measures are unavoidable and in the special interest of the general public. There seem to be no real practical problems which could not overcome. From the subsidiarity point-of-view there is no need for an EU-wide unique solution.

The need for the active and/or passive contribution of private landowners to the soil monitoring system needs further and deeper discussion;

- Active: Data and information to be provided by the landowner e.g. concerning land use, management, kind and amount of fertilizers.
- Passive: Sampling and measuring activities have to be tolerated on the privately-owned land as a result of the right of certain authorities to act on private land.

Directive 2003/4/EC exclusively regulates public access to environmental information.

Everything becoming part of the monitoring directive must comply with Article 7 of Directive 2003/4/EC. Therefore, every proposal for the monitoring directive must be in line with the spirit and the regulations of Directive 2003/4/EC.

The use of data for commercial purposes or being privately owned either for the future EU monitoring system, or deriving from it, has to be regulated by contract.

Close cooperation will benefit the activities of INSPIRE and the Soil Thematic Strategy. Initiatives to this end should be taken. The Commission soon will adopt proposals from both. These proposals should refer to each other.

Cost estimates

There was an intensive discussion, but no majority opinion within the Working Group on the question of whether a systematic grid (at whatever level) will be the right approach or if, as a first step, it could be more effective to act at a level of representative sites selected by Member States (cost-benefit analysis).

The Chair wishes to remind people of the fact that according to EUROSTAT statistics,
the EU 25 members cover an area of **3.972.868km^2.**
For a **16 x 16** km grid-based sampling this would imply **15.519 measuring points,** for an **8 x 8** km sampling grid this becomes **62.076 measuring points.**

Thus, it becomes very obvious that as long as there is no clear picture of the future soil monitoring needs, a serious over-all cost estimate at this stage of the work is not possible. Therefore, we attempt to give only a picture of the costs of certain elements of soil monitoring.

Germany has made a preliminary estimate of the costs for the acquisition of the basic site description parameters (mostly identical with the General Parameters proposed by the respective Task Group), according to internationally agreed standards, of around €6,000 per site and the laboratory costs for the analysis of around 20 of the most relevant parameters at around €4,000 per site. Note that these costs could be incurred BEFORE a decision is made to accept a site for monitoring because detailed investigation might show it to be unsuitable for the intended purpose. Thus a significant part of the initial costs have a risk element attached, but of course they are only incurred once. In England and Wales, costs are approximately two-thirds of these values, in Portugal they are about half, and in Hungary somewhat less than in Portugal. These differences clearly reflect different staff costs etc., BUT they doubtless fall equally heavily on local budgets, and are substantial when viewed in the light of the number of sites to be monitored.
This picture shows very clearly that because of the different staff costs only cost ranges can be offered.

Germany has calculated the costs for repeat sampling of the basic 18 parameters proposed, with the following result:

Revisiting the sampling site	200€
Taking soil samples at 2 different depths	45€
Parameters for soil physics	140€
Parameters for inorganic soil chemistry	215€
Parameters for organic chemistry	200€
Microbial Biomass and basal respiration	60€
Dioxins/Furans	350€
Earthworm population with differentiation	600€
Total	1810€

To repeat: the expected costs per site and per sample for the selected sampling sites and the baseline

investigations are calculated to be between 5000€ and 10000€, the repeat sampling of 18 basic parameters will cost between 900€ and 1800€. Costs for each additional indicator/parameter must be calculated separately and added to these sums.

A cost-benefit estimate cannot be provided at this stage.

Final conclusion and recommendations

RECOMMENDATIONS FOR SOIL MONITORING

1) The European Community needs a soil monitoring initiative at the Community level because there is an over-riding need for information to support well-informed soil protection strategies and management practices across all Member States, and the evaluation of relevant policies at the European level. The information will support Community policy and legislation in relation to soil, its functions, and its related environmental compartments.
2) Such an initiative will also be a stimulus to national soil protection strategies and their evaluation, and will also give coherence to trans-national information collection and reporting.
3) Therefore, the European Commission should institute a step-wise approach to the soil monitoring process, based – wherever possible – on existing systems, in order to provide a mechanism by which to better manage and protect soil and its functions in a sustainable, fair, cost-effective, and transparent manner across all Member States.
4) The raison d'être of the soil monitoring process should be the systematic examination of soil, the drivers and pressures on it, and the resulting impacts and responses that affect soil, both in time and space.
5) The first action for the soil monitoring process should be the establishment of a Co-ordination Group that will be responsible for the production of technical guidance and protocols for the collection, quality assurance and quality control, storage and distribution of information. This action should be based on the evaluation of existing soil monitoring processes and their component parts, and take into account the suggestions from the various Working Groups.
6) The second action should be for the Co-ordination Group to produce advice for the identification of risk areas based on the various threats to soil, and for the targeted monitoring of these areas although soil monitoring in general should not be restricted to these risk areas.
7) Another action should be the establishment of a baseline (time zero) inventory of soil properties thus allowing for a comprehensive assessment of soils across Europe. This inventory would be the datum for future rounds of soil assessment.
8) In respect of the target of harmonization of standards and optimization of monitoring systems, it would be helpful (and it seems to be necessary), to integrate existing directives such as FOREST FOCUS and the Nitrates directive as an important part of the future soil monitoring strategy.

RESEARCH, SEALING AND CROSS-CUTTING ISSUES

Winfried E. H. Blum, Jürgen Büsing
Thierry de l'Escaille

Summary

Priority research areas for soil protection and the management of Europe's natural resources based on DPSIR

Cluster 1: Processes influencing soil functions and quality

Analysis of processes related to the 8 threats to soil and their interdependency: erosion, loss of organic matter, contamination, sealing, compaction, decline in biodiversity, salinisation, floods and landslides

Cluster 2: Spatial and temporal changes of soil processes and parameters (state S)

Development, harmonisation and standardisation of methods for the analysis of the State (S) of the 8 threats to soil and their changes with time = soil monitoring in Europe

Cluster 3: Ecological, technical, economic and social drivers of soil threats (Driving forces and pressures, D + P)

Relating the 8 threats to Driving forces (D) and Pressures (P) = cross linking with social and economic drivers, such as EU and other policies (agriculture, transport, energy, environment etc.) as well as with ecological drivers, e.g. global and climate change

Cluster 4: Factors (threats) influencing soil eco-services (Impacts, I)

Analysis of the Impacts (I) of the 8 threats, relating them to soil eco-services for other environmental compartments: air, water (open and ground water), biomass production, human health, biodiversity

Cluster 5: Strategies and operational procedures for soil protection (Responses, R)

Development of operational procedures for the mitigation of the threats = Responses (R)

Introduction

The Technical Working Group Research, with about 65 members, met four times:

- 1st Meeting on June 6, 2003 in Vienna (Austria)
- 2nd Meeting on October 6-7, 2003 in Wageningen (The Netherlands)
- 3rd Meeting on January 8-9, 2004 in Barcelona (Spain).
- 4th Meeting on April 20, 2004 in Brussels (Belgium)

During the first meeting in Vienna, 9 Task Groups were defined (names of Task Group leaders in brackets):

Task 1: "Erosion, compaction, floods and landslides" (Coen Ritsema, Anton Imeson);

Task 2: "Contamination (local and diffuse)" (Johan Van Veen, Christian Buhrow, Ilse Schoeters);

Task 3: "Organic matter, biodiversity" (Carlos Garbisu, Stephen Nortcliff);

Task 4: "Salinisation" (Francesco Bellino, Giuseppina Crescimanno);

Task 5: "Sealing, urban soils, land use, land use planning" (Wolfgang Burghardt);

Task 6: "Monitoring, harmonisation, spatial data, GIS" (Dominique King, Luca Montanarella, Paolo Giandon);

Task 7: "Soil and data property, soil legislative framework, soil conservation service"(Stef Hoogveld, Thierry de l'Escaille);

Task 8: "Awareness, education networking, capacity building, co-operation" (Peter Costigan);

Task 9: "Good status, soil-water systems, soil quality, soil health" (Ludo Diels, Dominique Darmendrail).

The Task Groups reported, based on the DPSIR-Framework approach (see Fig. 1) and under the specific mandate of the Working Group:

- identification and structuring of the existing information;
- barriers that prevent the full use of existing results for policies and applications (e.g. commercial use), and recommendations how to improve the transfer of information;
- identification of research gaps with indication in which time interval these can be closed (short-, medium- and long term activities).

The reports of the Task Groups are published separately.

The following research proposals, elaborated by the Working Group were arranged under five main research clusters, as discussed and convened in the 3rd Meeting in Barcelona, Spain.

These research clusters are shown in Fig. 1, ranging from 1-5 and are corresponding to the main research goals as shown in Tab. 1.

By re-formulating the research targets into research topics, five priority research areas for soil protection and the management of Europe's natural resources, based on DPSIR were formulated, see Fig. 3.

In Tab. 1, these priority research areas can be seen, as well as the sciences which should be involved in inter-disciplinary and multi-disciplinary research within these priority research areas.

Finally, it seems important to inform that the main focus of the discussions was directed towards soil protection in the sense of prevention and not of remediation.

Fig. 1:

The DPSIR Framework Applied to Soil

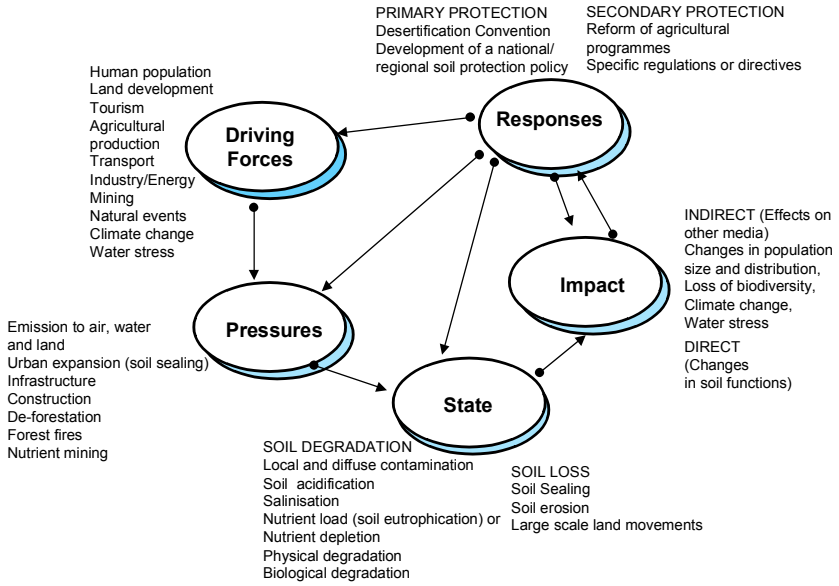
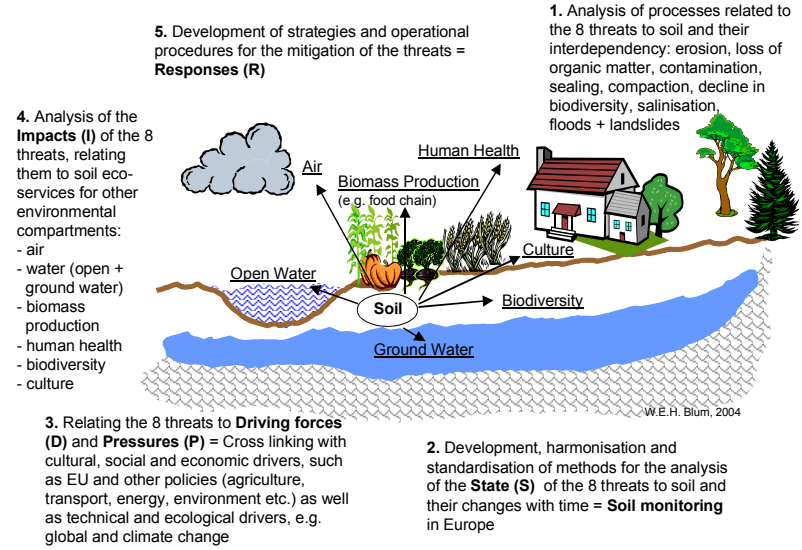


Fig. 2:

THE 5 MAIN SOIL RESEARCH CLUSTERS



Tab. 1:

CONCEPT FOR INTEGRATED RESEARCH IN ECOLOGY – EXAMPLE SOIL

	MAIN RESEARCH GOALS	PRIORITY RESEARCH AREAS	SCIENCES INVOLVED
1	To understand the main processes in the eco-subsystem soil; induced by threats	Processes influencing soil functions and soil quality	Inter-disciplinary research through co-operation of soil physics, soil chemistry, soil mineralogy and soil biology
2	To know where these processes occur and how they develop with time	Spatial and temporal changes of soil processes and parameters **(State S)**	Multi-disciplinary research through co-operation of soil sciences with - geographical sciences, - geo-statistics, - geo-information sciences (e.g. GIS)
3	To know the driving forces and pressures behind these processes, as related to policy and decision making on a local, regional or global basis.	Ecological, technical, economic and social drivers of soil threats **(Driving forces and Pressures, D+P)**	Multi-disciplinary research through co-operation of soil sciences with political sciences, social sciences, economic sciences, historical sciences, philosophical sciences and others
4	To know the impacts on the eco-services provided by the sub-system soil to other environmental compartments (eco-subsystems)	Factors (threats) influencing soil eco-services **(Impacts I)**	Multi-disciplinary research through co-operation of soil sciences with geological sciences, biological sciences, toxicological sciences, hydrological sciences, physio-geographical sciences, sedimentological sciences and others
5	To have operational tools (technologies) at one's disposal for the mitigation of threats and impacts	Strategies and operational procedures for soil protection **(Responses R)**	Multi-disciplinary research through co-operation of natural sciences with engineering sciences, technical sciences, physical sciences, mathematical sciences and others

W.E.H. Blum and J. Büsing, 2004

Priority research areas for soil protection and the management of Europe's natural resources, based on DPSIR

Cluster 1: Processes influencing soil functions and quality

Analysis of processes related to the 8 threats to soil and their interdependency: erosion, loss of organic matter (SOM), contamination, sealing, compaction, decline in biodiversity, salinisation, floods and landslides

Erosion:

Understanding the chain of processes between bio-physical drivers of water and wind erosion and ecological and socio-economic effects, with emphasis on model improvement and scale issues. Understanding of the relationship between erosion and the development of sediments.

Compaction:

Quantification of strengths, deformation and compaction of soils and stress transmission in soils; Implementation of new models for prediction of stress transmission and soil deformation.

Floods:

Understanding of the water storage capacity in river basins (soil water storage, soil moisture; influence of vegetation and land use changes; influence of soil sealing (cross-cutting)).

Landslides:

Better understanding of field strength and stability, effects of vegetation, impact of land use changes (via hydrology).

Contamination:

Development of methods for the identification and quantification of contamination sources (both geogenic and anthropogenic), especially diffuse contamination, the route of entry and the fate of contaminants into/in the environment and assessment of the spatial and temporal variations.

Understanding of the capacity controlling factors in soil influencing long term behaviour of contaminants in soil;

Understanding of the impact of contamination on the soil/water/sediment- system (the subsurface), including speciation and short and long term fate of pollutants in soils.

SOM:

SOM in relation to soil functions;

Impact of changes in SOM in relation to:

- the role and turnover dynamics of the fractions of SOM;
- the role and turnover dynamics of soil meso-, macro-, and micro-organisms at sub-molecular levels and higher;
- the nature of the relationships between SOM fractions and soil organisms;

Upscaling from field to regional and global scales;

- characterisation of soil biodiversity in selected key, natural and managed ecosystems, including ecosystems currently undergoing change from natural and anthropogenic processes;

- Understanding of the multiple function of SOM and biodiversity in order to be able to present confidently policy guidance and the management of these soil properties;
- Analysis of reversibility and irreversibility of processes linked to the management of carbon in soils by different agricultural and forestry practices.

Salinisation*:*

Investigation of the interrelationships between the physical, chemical, mineralogical and hydraulic properties of soils which make a soil sensitive to salinisation/sodication and determination of its response to drivers and pressures;

- the reversibility of the soil degradation processes caused by salinisation/sodication;
- how to measure soil resilience and soil renewability;
- how to translate these concepts into measurable parameters/indicators;
- how the water flow conditions (Darcian flow, bypass flow) in the saturated/unsaturated zone may influence the processes of salinisation and sodication, as well as strategies for salt-reclamation;
- pedotransfer functions to be used for predicting soil parameters and scaling-up procedures; inter-relationships between salinisation/sodication and desertification.

Sealing*:*

- Establishment of a harmonised nomenclature for the terms sealing, land consumption and soil consumption, which can be applied to compare data between countries;
- Establishment of methods to survey sealing in respect of area quality and quantity, analyse ways of flexible use and interaction with sealed areas;
- Investigation, quantification and assessment of impacts of sealing on soil qualities and soil æunctions, on health and human environment and nature;
- Establishment of methods to assess how much sealing is necessary and bearable under a given economic development and the area limitatons due to mountainous topography, rivers, coastal plains and others;
- Impact of sealing in social and economic fields;
- investigate the benefits for soil and nature and develop assessment methods;
- investigate the economic benefits and develop assessment methods;
- investigate the indirect effects of sealing with special focus on the fragmentation of habitats.

Monitoring*:*

Short term

Recovery, evaluation, upgrading and accessibility of existing data.

Including:
• The comparison of results of different sampling and analytical methods;
• The development of standardized methods and common criteria to define pedotransfer functions.

Medium term

• Upscaling of local data (multi-scale approach);
• Definition of soil quality indicators on the basis of available data (existing soil maps, remote sensing, etc.).

Cross-cutting:

- Identification of specific soil potential requirements in relation to soil types;
- Definition of criteria/limits of soil potential (internal) and soil use (external) that lead to initiation of soil degradation and irriversible changes of soil parameters;
- Upscaling and downscaling of the understanding of the functioning of the different processes;
- Listing of soil functions of importance for each soil use, soil properties that determine soil functions, properties to characterize soil quality in relation to soil potential.

Cluster 2: Spatial and temporal changes of soil processes and parameters (state, S)

Development, harmonisation and standardisation of methods for the analysis of the State (S) of the 8 threats to soil and their changes with time = soil monitoring in Europe

Erosion:

Extension of existing research facilities to create long-term monitoring sites, to support fundamental research, calibration and validation of models, up-scaling and extrapolation, finding indicators, and risk assessment using soil information systems and remote sensing.

Compaction:

Assessment of existing compaction levels in European soils.

Floods*:*

Flood risk assessment across Europe, including sedimentation risks.

Landslides*:*

Land slide risk assessment across Europe, including soil stability research.

Contamination*:*

Production, validation, optimisation, and harmonisation (in view of standardisation) of exhaustive, reliable, and economical measurement methods for all steps of the characterisation of soil contamination (sampling, analysis, background levels, etc), specifically addressing:

• sampling, identification and quantification of new substances (e.g. VOCs, known and emerging pollutants) in soils;
• early warning systems (ex.sensors) for soil pollution;
• passive sampling technologies related to soil pollution;
• indicators/tracers for the assessment of soil quality and functioning;

- interdependencies of effects and behaviour of substances in soil under different conditions, in order to better organise the site characterisation.

SOM:

Research on the development of standardised methods for the characterisation of the nature and function of the SOM pools from a biological and structural perspective in contrasting environments across Europe;

- development of standardised methods to characterise the biodiversity of micro-organisms in soil, if this is a property to be monitored;
- the selection of organisms as indicators to be monitored, taking into account the ease of measurement, the value as an indicator and the relationship with other organisms;
- Provision of a scientific basis for a minimum data set, appropriate for the a.m. purpose across the contrasting natural and managed ecosystems in Europe. Those methods will probably be at a range of scales from whole organisms through to a characterisation of the functional (mRNA) and the protein level;
- research on the spatial and temporal scales at which measurements of SOM pools and biodiversity should be monitored.

Salinisation:

- Identification of indicators for monitoring trends in salinisation/sodication. (Salinity is usually expressed by measuring the Electrical Conductivity (EC) on the soil saturated extract. The Exchangeable Sodium Percentage (ESP) or the Sodium Adsorption Ratio (SAR) of the saturated extract represent the main indicator(s) of the hazard of sodication);
- Monitoring of effects of salinity and sodicity on soil structural and hydraulic properties (aggregate stability, water retention and hydraulic conductivity);
- Harmonisation of measurement techniques used to measure indicators of soil properties.

Sealing:

- Development of sealing survey and monitoring methods;
- Evaluation of existing methods for the quantification of the degree of sealing and development of a standard ("sealing degree") assessment procedure;
- Development of standard sealing quality assessment methods with the inclusion of regional demands and specifications such as natural differences;
- Implementation of pilot projects on sealing survey, monitoring and assessment;
- Establishment of methods for urban soil and soil substrate survey and monitoring;
- performing pilot projects for surveying urban, industrial and traffic areas;
- establishing monitoring and assessment methods for sealing which include the original and current quality, occurrence and rarity of soils, and sensitivity of soils to sealing;
- Development of criteria for the determination of intervals of sealing and urban soil monitoring;
- Development of methods to monitor soil use, socio-economic and planning parameters, and population development, and their importance for soil sealing.

Monitoring:

Short term

- improvement of soil sampling representativity;
- monitoring without disturbance, taking into account soil volumes or soil patterns (e.g. horizons, typological units).

Medium term

- Development of

- new technologies (e.g. geophysical, digital terrain models, etc.) for the acquisition of more relevant data at different scales;
- innovative methods allowing a quantification of spatial and temporal variability of soils (e.g. geostatistics, 3D modelling, etc.);
- methodologies to integrate basic soil data, soil monitoring data and information coming from these new methodologies.

Long term

- Measurement of slow changes (e.g. long term monitoring sites, time soil sequences ...);
- integration of soil variables with other environmental components for global monitoring.

Cross-cutting:

- evaluation of dynamics indicators for e.g. land use changes and its impacts on soil quality and assessment of the vulnerability to changes (buffer capacity);
- identification and selection of Soil Quality Indicators (SQI) and their relationships (models/functions). SQI are needed to establish reference or benchmark values to which preservation or restoration activities should aim.

Also they could help to determine the environmental damage. Definition of a minimum data set of parameters for soil quality assessment (biological, chemical, etc.) in a hierarchical scale;

- monitoring of soil quality in various settings (agriculture / forestry / natural areas / urban) to create a knowledge basis for decision support systems.

This should be concerted with and conducted in the European country. It is especially needed for the NAS which have had very diverse environmental legislations and social and economical development. Database of good quality for each of the soil properties

- Standardization of methods and procedures for soil quality assessment in relation with soil functions and soil potential

Cluster 3: Ecological, technical, economic and social drivers of soil threats (Driving forces and Pressures, D + P)

Relating the 8 threats to Driving forces (D) and Pressures (P) = cross linking with social and economic drivers, such as EU and other policies (agriculture, transport, energy,

environment etc.) as well as with ecological drivers, e.g. global and climate change

Erosion:

Understanding of the impact of

- land use change (climate and policy driven);
- climate change (frequency magnitude, amplitudes);
- land management: land levelling, tillage displacement;
- spatial impacts: desertification, forest fire, snow melt on erosion.

Compaction:

- quantification of soil conditions which are sensitive to compaction;
- assessment of actual trends in the technical-industrial development of agricultural machinery, causing deep reaching compaction.

Floods:

Impact of climate (frequency, magnitude), climate change, and connectivity for quickflow on flood events.

Landslides:

- Impact of climate and climate change (frequency, magnitude), soil hydrology, ground water systems, and geology on landslides.

Contamination:

- Definition of criteria and harmonisation of methodologies for the identification of potentially dangerous chemicals (priority substances for the terrestrial environment).
- Identification of the socio-economic driving forces (money, education, regulation, administration), the influence of soil management and of land use in general (e.g. change to different chemicals, change of crop rotation system, cattle unit allowed per acre, no-till, soil-protection as a trade-off) on soil pollution and quantification of their effects.

SOM:

- Research on effects of climate change and related land use changes on SOM-levels and -pools and biodiversity;
- research on effects of management practices of farming and other land uses (e.g. additions of exogenous organic matter (EOM) to soil; changes in tillage practices; conventional V-integrated-V-organic farming; incorporation of residues from GM-crops; restoration of damaged land) on SOM levels and pools and biodiversity;
- Identification of combined practices which can optimise SOM and soil biodiversity (e.g. combination of reduced tillage and additions of EOM);
- different contributions of different agricultural crops and plant covers in influencing SOM levels and pools and soil biodiversity;
- effects of the presence of contaminants on the role and functions of the SOM pools and soil biodiversity;
- characterisation of the potential of soils to sequester carbon under contrasting environmental conditions; are there broad principles which can be provided across Europe or which specific climate-landscape combinations?
- what are the requirements for developing modelling approaches which suggest outcomes with sufficient precision to be incorporated in policy and guidance frameworks.

Salinisation:

Investigation and quantification of

- the influence of the different drivers (i.e. intensive agriculture requiring use of saline water for irrigation and/or waste-waters) on the processes of salinisation and/or sodication under different levels of pressures (i.e. climate with increasing temperature and evapotranspiration, with dry seasons during which irrigation is necessary to keep acceptable levels of crop yield, and erratic rainfall; intensive use of soil and of irrigation);
- the role of (improper) water and land management as driver/pressure needs to be better quantified;
- RTD on how to integrate actions and policies preventing salinisation/ sodication into programmes for the management of water resources (eg. European Framework Directive), environmental and agricultural programmes, and/or desertification programmes (UN Convention for Combating Desertification, UNCCD).

Sealing:

- Establishment of parameters for the socio-economic needs for sealing;
- establishment of monitoring methods for identifying the land users, land owners and planners and their demands, and the needs for sealing with regard to land use types;
- Establishment of rules for the determination of the minimum surface and spatial distribution pattern, and the quality of soils in areas which have a high degree of sealing;
- Evaluation of the implementation of the ESPON (European Spatial Planning Observatory Network) project and integration of land consumption in the analysis of the effects of territorial policies like TEN, structural funds, CAP.

Monitoring:

Short term

- soil mapping and monitoring, to characterise soil evolution under anthropogenic impacts on large areas, in order to answer the following questions:

• Are local studies concerning threats, related pressure and driving forces representative for larger areas?

• How far away can we extrapolate data values without losing too much accuracy? How do we measure map's uncertainty?

• Which are the best methodologies to collect, compare, and analyse data coming from different studies about soil degradation processes for the sole purpose of impact threat assessments?

Long term

- to understand basic mechanisms responsible for the time-related impact contribution to soils, resulting from combined effects of human actions, biological activity and climate (e.g. comparison between human impact at short term and pedogenetic factors at long term).

Cross-cutting:

- research on aspects of the community soil ownership (its nature and duration) and the development of soil value as a function of time, use and region in close cooperation with the INSPIRE initiative. This will benefit the activities of INSPIRE and the Soil Thematic Strategy. Initiatives to this end should be taken. The Commission soon will adopt proposals from both. These proposals should refer to each other;
- in-depth evaluation of existing EU policies having direct or side effect on soil;
- in-depth evaluation of successful regional experiments with respect to the scaling up to larger parts in Europe;
- analysis of the variety of existing soil protection laws in EU member states not including remediation aspects, and in-depth evaluation of existing EU soil protection legislation, with specific reference to legal and political instruments and competence;
- objectives, structure and capacities of regional and national Soil Conservation Services that are already well established, and those objectives and regions that are not covered by administration, management, improvement measures and research;
- the demands on Soil Conservation Service objectives, structure and capacities at regional, national and European levels.

Awareness:

- improve public awareness of the values of soils, among others as part of our geoheritage; This could be achieved by providing funding for the production of publicly accessible information on soils and their interpretation. These have to be locally produced to be relevant;
- increase the awareness of scientists and professionals to the importance of soil. Scientific societies should also be involved.
- help express the social demand toward soil and renew the teaching of soil by specific programmes (e.g. developing multidisciplinary field studies for students and training courses for teachers of primary and high schools, etc);
- on political awareness, it is important to develop robust indicators of soil quality, which are soundly based in scientific evidence. Demonstrate the way in which soil is intimately linked to the sustainable development agenda. This should create a clear political direction for future protection of' soils;
- develop information for land managers and their advisers. The lack of a common understanding of soils leads to a difficulty in communicating the important factors in land management;
- in particular, materials and methods should be developed for integrating different issues of soil protection (soil biodiversity, erosion, pollution, etc) into agricultural and rural development programmes and training processes for farmers and technicians;
- develop better networking and collation of research information, both funded from the Commission and from national funds. Continue to develop
- relevant networking opportunities focussed on specific sectoral issues. Create a single website where links to information about soils could be collated;
- re-all above, produce evidence why soil should be considered beyond the legislative "contamination" issues and the agricultural productivity/fertility context.
- link between soil quality, environmental indicators and social, economical, and human health indicators;
- effect of land use planning and changes on the functioning of the soil and landscape system;
- what are the relations between diffuse pollution and:
    - agriculture – forestry;
    - transport;
    - energy;
    - mining areas in the countryside

Cluster 4: Factors (threats) influencing soil eco-services (Impacts, **I)**

Analysis of the Impacts (I) of the 8 threats, relating them to soil eco-services for other environmental compartments: air, water (open and ground water), biomass production, human health, biodiversity

Erosion:

- analysis of ecological and socio-economic impacts and definition of sustainable land management;
- improvement of knowledge on the inter-linkage between soil erosion and biodiversity change.

Compaction:

- quantification of compaction effects on soil functions;
- improvement of models predicting and describing effects on soil functions.

Floods:

- Analysis of ecological and socio-economic impacts of floods using monitoring and modelling.

Landslides:

- Analysis of ecological and socio-economic impacts of landslides, using monitoring and modelling.

Contamination:

- improvement and harmonisation of the conceptualisation and the modelling of the transfers of contaminants from and within the soil and of the subsequent risks, specifically addressing:
    - bioavailability for humans (soil ingestion, inhalation, dermal uptake);
    - bioavailability to plant and soil organisms;
    - quantification of outputs from soil, e.g. leaching;

- vapour transfer from soil into outdoor and indoor air;
- integration of the background exposure;
- (eco)toxicological reference values and their uncertainty/reliability;
- impact of diffuse pollution on groundwater.

- improvement of risk assessment methodologies for:
  - remediation activities on a contaminated site;
  - re-use of waste as a soil (ashes from incinerator, foundry sands,…);
  - impact of agriculture practices on soils (sewage sludge, fertilisers,…);
  - fate and impact of diffuse pollution and eutrophication by deposition in near-natural ecosystems of Europe.
- construction of a" fit-for-use" tool box for risk modelling for use in (parts of) Europe, including:
  - documentation on the sensitivity of calculated exposures to the input parameters and guidelines on when and how to measure concentrations in contact media;
  - information on the uncertainty/ reliability of the calculated human and ecological exposure.
- development of flexible but harmonised methods for establishing "tolerable loading" in soil;
- development of a conceptual basis for combining different sources of spatial/temporal variability (physical, chemical, biological) for complex soil and ground water systems.

SOM*:*

- Understanding the role of the SOM pools in relation to soil functions;
- - Understanding the relationship between the structural and functional properties of soil biodiversity and soil functioning;
- of particular importance: to understand the "tolerances" of these relationships, the resilience to change in soil functioning and the extent and rate of recovery; understanding the role of GMOs in soil functions.

Salinisation:

- Impact of salinity (cationic concentration) on crop productivity and yield, with economic evaluation;
- Interaction between salinisation /sodication and the structural and hydraulic characteristics of soil, water transport in the vadose zone, water available for crops and evapotranspiration, bio-diversity;
- the economic and social impact of salinisation/sodication (e.g. changing crops towards more tolerant ones, sometimes with less economic advantage, additional costs for farmers in order to build drainage systems or to use more water to perform salt-leaching; unemployment and land abandonment, with some extreme consequences in different countries;
- how different levels of salinisation/sodication affect sealing and crusting, water balance, infiltration and runoff, and erosion at different scales.

Sealing*:*

- Investigation of the effect of sealing on the mass-, element- and energy flow in urban, suburban and rural areas;
- Analysis of impacts of sealing on local, landscape and global level in relation to sealing degree and quality parameters for sealing and soils;
- Establishment of socio-economic costs of inadequate use (not corresponding with the preferred soil function) of soils by sealing;
- Assessment of the benefits and negative impacts of land use planning on sealing.

Monitoring:

Long term

- to develop deterministic (mechanistic) and / or stochastic models (or their combinations), including their comparison and validation (to be performed in chosen sites of the research pilot areas network), able to:
- define the variability of soils and their properties in space and time (a common soil database at EU level is needed - EUSIS);
- integrate information regarding other environmental compartments; establish scenarios of soil impact status under different human activities and climate conditions.

This includes:

- the development of a common dataset of soil properties and characteristics to employ in impact assessment at European, national and regional level through a multi-scale approach, by competent bodies (EUSIS extensions);
- the comparison of different models of soil impact threat assessments and soil risk assessments using the above mentioned dataset;
- the improvement of soil mapping and monitoring information used in modelling (a) soil impact threat assessments, and (b) pertinent relationships with related environmental compartments.

Cross-cutting*:*

- impact on soil quality related to changes, e.g.:
  - influence of climate change on soil quality;
  - changes of soil use;
  - how to deal with changing soil potentials;
  - impact of diffuse pollution;
  - assessment of multisources impacts in a catchment area (different land uses, different soils, different stakeholders).

Cluster 5: Strategies and operational procedures for soil protection (Responses, **R)**

Development of operational procedures for the mitigation of the threats = Responses (R)

Erosion:

- increase of education and awareness; development of new conservation and remediation methods on agricultural lands; definition of tailored conservation methods.

Compaction:

- development and evaluation of management tools to reduce sub-soil compaction.

Floods:

Development of flood management strategies:

- land use planning (giving space to the rivers);
- development of legal instruments

Landslides:

-Development of:

- early warning systems;
- prevention measures (technical, land use change).

Contamination:

- identification of soil functions which contribute to natural attenuation capacities of soil and its preservation (link with cluster 1);
- improvement of the quantification of natural soil rehabilitation processes and of their consistency with impact assessment;
- development of methods for the comparison of alternative management options that take into account the environmental and socio-economic conditions (evaluation of risk based approaches in decision support systems).
- development of containment devices and techniques for safe storage, handling and transport of substances that may contaminate soil and groundwater;
- assessment of the sustainability/persistence of different remediation technologies and their environmental impacts;
- development of economic models to assess the balance between costs and benefits, especially in the context of the cleaning up of contaminated soils.

SOM:

- investigate and evaluate the effects (positive and negative) of SOM pools and functions of different levels of tillage, across a range of environmental conditions;
- investigate and evaluate the effects (positive and negative) of the incorporation of a range of exogenous organic materials on SOM pools and functions and soil biodiversity;
- investigate how to influence the resilience of SOM levels and pools and soil biodiversity as influenced by changing environmental conditions.

Salinisation:

The following actions are necessary as a response:

- to collect updated and reliable information on the status of salinisation and sodication in Europe, and of other information related to the process of salinisation and sodication (establishing a network in Europe);
- to identify areas threatened by salinisation and sodication in different countries by measuring the suggested indicators (EC, ESP/SAR, critical ground water depth and critical ground water salinity);
- to perform validation/calibration of models predicting transport of water and solutes for selection of management strategies scenarios (i.e. alternative irrigation methods and scheduling, calculation of leaching requirement, conjunctive use of different irrigation waters, amendments, etc) or alternative land uses accounting for the social and economic consequences of land degradation;
- to increase awareness of the risk of land degradation (desertification) linked to the processes of salinisation and sodication (stakeholders);
- to integrate actions and policies preventing salinisation/ sodication into other European Programmes (Water, Environment, Agriculture, Combat of Desertification).

Sealing:

Research is necessary to:

- establish a convention on the restriction of soil consumption and possible effects on soil protection at a local, regional and European level;
- establish legal and other instruments for the control of urban growth and its harmonisation with soil quality;
- establish regional threshold values for sealing;
- integrate potentials of landscape types and their sealing potential into land development plans;
- mitigate sealing problems by change of land use, production, commerce, transport systems and communication technologies and other driving forces and pressures;
- develop legal instruments, e.g. economic, fiscal and planning instruments needed to reduce sealing and sealing effects;
- develop measures for reducing sealing effects and for mitigating them;
- determine the tasks and develop instruments for a Soil Conservation Service in urban, industrial and traffic areas with a strong focus on sealing.

Monitoring:

Medium term

- methods to derive maps from soil databases (combined with other databases) for assessing policy (land and water management, soil planning, agricultural policy, waste recycling, etc.);

Long term

- establishment of scenarios for estimating impacts of climate and/or anthropogenic changes: operational

tool to forecast the consequences of the Common Agricultural Policy or other European policies.

Cross-cutting:

- monitoring of the efficiency of prevention, conservation and mitigation technologies;
- identification and qualification of risk levels related to the different threats and their acceptance by the different users, e.g.:
  - mixed pollution treatment;
  - control (risk management) versus total clean up;
  - residual concentrations – rebound;
  - dynamic behaviour of soil services/potentials;
  - prevention of contamination due to flooding;
- aim at a unique solution to describe the variables geodiversity and geoheritage.

Some additional inventory is needed to that end.

Monitoring, harmonisation, spatial data, GIS

Two general actions are recommended as infrastructure for further research development on soil monitoring, although they do not constitute research aims in themselves:

1. to undertake a soil inventory on a common standardised method at medium scale (minimum information 1:250.000), creating an effective and easily accessible EU Soil Information System (EUSIS);
2. to establish a network of pilot areas representative for the main soil landscapes in Europe, in which to set up main research initiatives investigating different soil types.

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